Information Series No.12

PROGRAM AND SUMMARIES

Tenth Annual

Open House and Review of Activities

November 19 and 20, 1986

Honourable Joel R. Matheson, Q.C., Minister
John J. Laffin, P.Eng., FEIC, Deputy Minister
HALIFAX, NOVA SCOTIA

1986

Nova Scotia
Department of
Mines and Energy

Canada - Nova Scotia
Mineral Development Agreement

Editors - J. L. Bates
D. R. MacDonald

Word Processing - R. Jones
B. MacDonald
L. Miller

Cartography - J. Campbell
P. Belliveau
W. Burt
G. MacDonald
J. Fownes
P. Fraser
R. MacPherson
W. Kaiser

Photography - R. Morrison
C. Phillips

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FOREWORD

It is particularly gratifying for me to welcome you to this Department's Tenth Annual Open House and Review of Activities. It represents not only an Anniversary event to be recognized, but also the first time we in this Department have had the pleasure of associating our Open House with a Canadian Institute of Mining and Metallurgy District One Meeting.

In the decade since the inception of this event and companion publication, our provincial mining industry has experienced major structural changes. Earlier concentration on base metals and uranium has now been replaced by emphasis on precious metals, especially gold, and on new coal developments. In the middle of this ten year period, the Canadian mining industry experienced its worst recession in this century. Nova Scotia's traditional mineral producers of coal, gypsum, salt, aggregate and limestone, maintained and expanded their production over this difficult time - a very commendable and exceptional achievement. Mineral exploration, however, declined significantly in parallel with international investment trends in this sector.

This year, with the particular initiatives of locally based and financed mining companies, onshore mineral exploration expenditures are expected to approach the historical highs established in 1980 and 1981. The major elements in this rejuvenation are gold, coal and gypsum.

Also over this decade, significant hydrocarbon reserves have been firmly established on Nova Scotia's offshore. The definition of these resources could only be accomplished with tremendous expertise and financing on the part of the private sector and exceptional co-operative support from all levels of government. If it were not for the downturn in international oil prices, I am certain that we would be entering the development stage.

The Department's continuing support and role in this exciting evolution is the subject of this publication and the presentations to be given by staff. The major governmental catalyst in this component continues to be our ongoing Federal-Provincial Mineral Development Agreement. I wish to acknowledge, with thanks, the contribution made by federal government and university professionals to this Tenth Open House in particular, and to the important co-operative mineral research accomplished over the last decade.

Joel R. Matheson

Joel R. Matheson, Q.C.
Minister of Mines and Energy

PROGRAM

WEDNESDAY, 19 NOVEMBER, 1986

20:00-21:00	Registration
20:00-23:00	Displays Open, Informal Social Evening Cash Bar

THURSDAY, 20 NOVEMBER, 1986

08:00-12:30	Registration
09:00-16:30	Displays Open

08:30-08:35	Call to order - Jack Garnett
08:35-08:45	WELCOMING REMARKS John J. Laffin, P.Eng., FEIC, Deputy Minister, Nova Scotia Department of Mines and Energy

ENERGY RESOURCES DIVISION

08:45-08:50	Energy Resources Division - Andrew Batcup, Director
08:50-09:00	Review of Oil and Gas - Paul Harvey
09:00-09:10	Review of Coal Investigations - John Calder
09:10-09:20	Oil Shale Project - Rob Naylor

MINERAL DEVELOPMENT DIVISION

09:20-09:25	Mineral Development Division - Jim Bingley, Manager
09:25-09:35	Mineral Inventory - Norm Lyttle
09:35-09:50	Industrial Minerals - John Fowler
09:50-10:00	Exploration Activity Review- Paul McCulloch
10:00-10:10	Mineral Resource Promotion - Dick Potter

10:10-10:30	**BREAK**

MINING ENGINEERING DIVISION

10:30-10:40	Mining Engineering Division - Pat Phalen, Director

FEDERAL PARTICIPATION IN THE CNSMDA

10:40-10:45	Canada-Nova Scotia Mineral Development Agreement - Jack Garnett

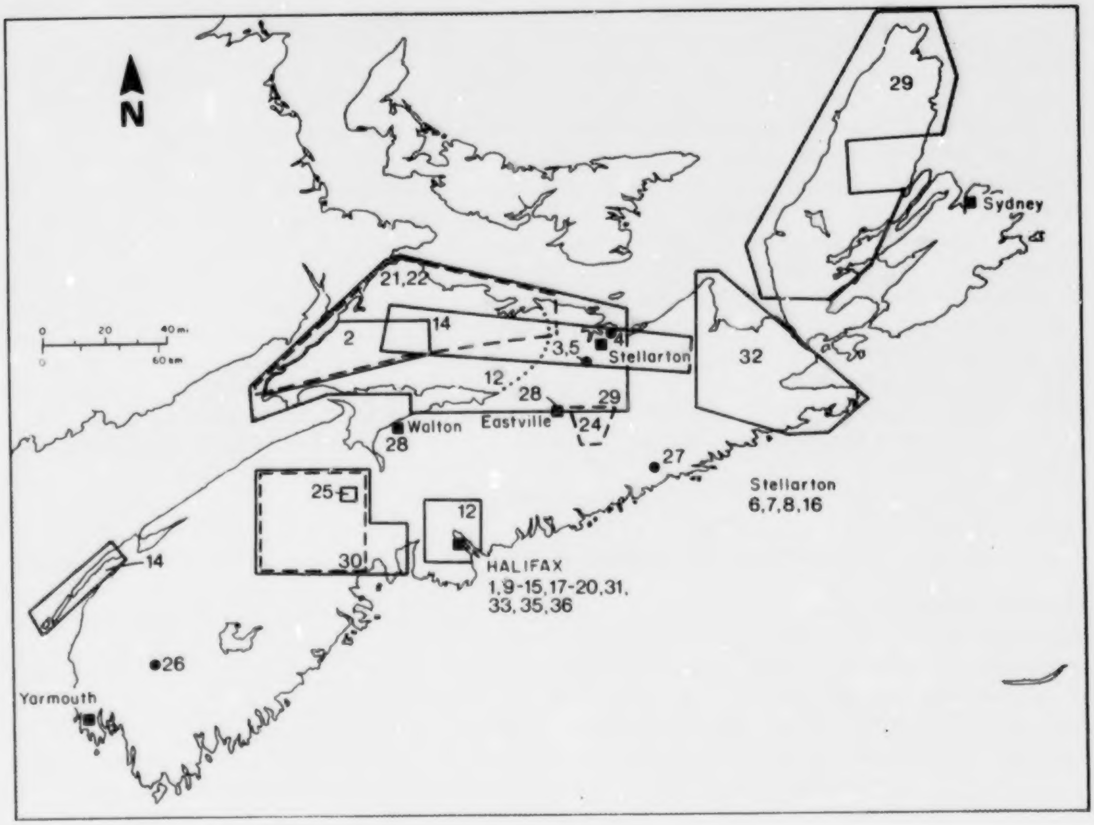
Federal Programs

10:45-10:55	Mineral Development Program - Don Stonehouse
10:55-11:05	Mineral Research and Technology - Don Doyle
11:05-11:20	Geological Survey of Canada (Geoscience Program) - Al Sangster

MINERAL RESOURCES DIVISION

11:20-11:25	Mineral Resources Division - Peter Giles, Director
11:25-11:40	South Mountain Batholith Project - Linda Ham

11:40-11:55	Gold Mineralization Research - Dan Kontak
11:55-12:05	Geochemical Investigations - Ron Mills
12:05-12:10	Education and Public Awareness - Howard Donohoe
12:10-12:15	Questions and Comments
12:15-16:30	Cash Bar
12:30-14:00	Buffet Lucheon Luncheon Speaker: Hon. Joel R. Matheson, Q.C. Minister of Mines and Energy
16:30	Displays and Open House close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NOVA SCOTIA DEPARTMENT OF MINES AND ENERGY PROJECTS 1986*

Energy Resources Division

1.** Petroleum Update
2. Coal Depositional Study, Cumberland Basin
3,5. Stellarton Basin Oil Shale/Coal Project
4. Trenton Syncline Oil Shale/Coal Project

Mineral Development Division

6.** Exploration Monitoring
7.** Drill Core Library
8.** Gold Map Compilation
9.** Gold Commodity Project
10.** Industrial Minerals (encompasses projects 11 to 15)
11.** Gypsum and Anhydrite Project, Windsor Basins
12. Aggregate Resources Project
13.** Fillers
14. Diatomite Resources Project
15.** Building Stone Project
16.** Various Commodities
17.** Drillhole and Mineral Occurrence Databases Project
18.** Mineral Resource Promotion Project
19.** Land Use Policy Development Project

Mineral Resources Division

20.** Metallotectonic Map of Nova Scotia
21,22. Cumberland Basin Project
23. South Mountain Batholith Bedrock Mapping
24. Liscomb Project
25. South Mountain Batholith Mineral Deposits Project
26. East Kemptville Project
27. Meguma Gold Project
28,34. Base Metal Project
29. Geochemical Stream Sediment Survey
30. South Mountain Batholith Pleistocene Survey
31,32, 33. Quaternary Geology and Till Geochemistry
35. NSDME Computerization Study
36.** Education and Public Awareness

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*Project numbers correspond to papers in Table of Contents
**Province-wide projects

PETROLEUM ACTIVITY UPDATE

P. J. Harvey

Nova Scotia's petroleum industry experienced some notable bright spots during 1986, despite a worldwide slowdown throughout the industry due to low world oil prices. Exploration in the Sable Island area resulted in two significant gas discoveries and the successful delineation of one oil field and two gas fields. On the regulatory side, the Governments of Nova Scotia and Canada concluded a new Offshore Petroleum Resources Accord which replaced the previous agreement signed in 1982. In the land management area, nominations from industry were received for crown lands and four parcels of crown lands were posted for which bids will be accepted in October. Onshore regulations governing Nova Scotia's oil and gas exploration and production activity were put in place and negotiations were successfully concluded for several onshore exploration agreements.

OFFSHORE

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM RESOURCES ACCORD

On August 26, 1986, the Governments of Nova Scotia and Canada signed the Canada - Nova Scotia Offshore Petroleum Resources Accord which replaces the 1982 Canada - Nova Scotia Offshore Agreement. This new Accord contains several significant improvements for Nova Scotia in the areas of offshore management and revenue sharing. The Accord has made Nova Scotia a full and equal partner in its offshore development and allows Nova Scotia to collect revenues as if the offshore resources were situated on land.

EXPLORATION

Seven wells were completed between October 1985 and September 1986. Two natural gas discoveries, West Olympia and North Triumph, were made during this period. The newly discovered North Triumph structure was successfully delineated and one previously discovered natural gas structure, Glenelg, was successfully delineated. A successful delineation well was drilled on Cohasset, an earlier oil discovery, and recorded the highest combined flow rates of any oil well drilled off the east coast of Canada. In addition to the wells completed, two wells are currently active at the time of this update.

The first Call for Nominations involving lands offshore Nova Scotia was issued to the petroleum industry in February 1986. As a result of industry's nominations, four parcels of lands were issued for bids which will remain open until October 8, 1986.

Mobil, Shell, Husky/Bow Valley and Petro-Canada, in conjunction with various partners, operated exploration programs during the past year. Early in 1986, a number of first round exploration agreements negotiated with these major operators, including Dome, expired and ten second round agreements were negotiated by governments and industry.

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During 1986, federal and provincial governments jointly prepared a detailed screening document for Georges Bank which analyzed the impacts of oil and gas exploration on the environment and the fishing industry in this area. The report will be reviewed by the petroleum and fishing industries and concerns will be completely addressed before exploration can proceed.

DEVELOPMENT

VENTURE GAS PROJECT

Two activities during the past year focused on bringing the Venture Gas Project closer to development. One of the United States gas purchasers initiated the first step towards securing approval to import our offshore natural gas into the United States by submitting an application to the pertinent United States regulatory body. Drilling continued on the Thebaud field to further define the extent and magnitude of reserves contained in this field.

COHASSET FIELD

Encouraging test results were obtained from the Cohasset A-52 delineation well in March 1986. These results have revived interest in developing the Cohasset oil field. Technical and economic feasibility studies are currently being done to assess the viability of developing this field in the near term.

ONSHORE

The proclamation of the Petroleum Resources Act in July 1984 was followed by promulgation of the Act's regulations on October 30, 1985. Companies with rights under the repealed Petroleum and Natural Gas Act had six months from that date to negotiate exploration agreements. By April 30, 1986, Chevron Canada Resources Limited and Irving Oil Limited, Sigma Resources Incorporated and Miles Company had negotiated exploration agreements that covered two-thirds of the land previously held under licences. A further exploration agreement has been negotiated with Consultants A.G.R.E.N. Canada Incorporated. These exploration agreements will result in future exploration activity onshore.

Final reports concerning onshore petroleum shows, wells and geophysical data are nearing completion and will be made available to all current and potential exploration companies.

TECTONO-SEDIMENTARY EVOLUTION OF THE CUMBERLAND GROUP IN THE CUMBERLAND COAL BASIN: IMPLICATIONS FOR COAL EXPLORATION

J. H. Calder

Calder (1986) identified a broad heirarchy of controls on coal deposition in the Springhill coalfield of the Cumberland coal basin (Athol Syncline). These controls were shown to affect the location, form and composition of the coal-forming mires (cf. swamps). Beyond the prerequisite of a favourable climate, the tectonic framework, patterns of basin fill, neighbouring geomorphic regions and ecology of the mires all influenced peat accumulation and preservation, in large part through their effect on groundwater distribution. These basic tenets may have wide application to coal deposits elsewhere in the Cumberland Basin, particularly when linked with recent tectonic and sedimentological studies by other workers elsewhere in the basin (Nance and Warner, 1986; Salas, 1986; Ryan et al., in press).

A first-order goal in coal exploration is to locate the coal deposits, which in the Athol Syncline are beneath the cover of younger overlapping strata. The location of the coal is believed to be a function of the tectonic setting and paleogeography of the basin (Calder, 1986), therefore these aspects of the regional geology must be understood. There is no consensus at present on the classification of the Cumberland Basin in terms of basin type (Boehner et al., 1986). Recent workers have referred to the Cumberland Basin during Westphalian B time as a pull-apart basin (Bradley, 1982; Mann et al., 1985; Keppie, 1982). Keppie (1982) placed this in the context of a regional "transpressional" system which had a later "foreland basin" stage during which the widely overlapping strata of the Pictou Group were deposited. In a recent thesis on the fluvial architecture of the Cumberland Group in the southwest of the Athol Syncline, Salas (1986) questioned the prevailing theory of strike-slip movement along the bounding faults and inferred that the sedimentary record may alternatively be attributed to deposition in an intermontane, foreland, forearc, or predrift graben basin (after Miall, 1981). Ryan et al. (in press) allude to the potential of the Athol Syncline as a rhomb graben which indirectly lends weight to a pull-apart origin in a broad sense, but most correctly a tilted fault-wedge basin (Ryan, personal communication; Ryan et al., in press). The closure of the rhomb required that an approximately north-south trending basement fault, down-thrown to the west, occurred immediately east of the Springhill coalfield, approximately underlying the Black River diapir. Such an inferred fault may explain the abrupt western terminus of the Claremont Anticline and coincides with the northwest-southeast "hypothetical subsurface arch" of Copeland (1959).

Evidence in support of a sub-basin with an eastern boundary in this location may be found in the relationship between the Riversdale and overlying Cumberland Groups. Bell (1938) described a "marked angular unconformity" on the Black River between these two groups, however the precise contact is not exposed at present either on Black River or the tributary Deep Brook. A re-evaluation of this important section is currently being undertaken as part of the Springhill sheet mapping project.

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The implications of such a structural configuration are significant to the understanding of the basin-fill evolution and to coal exploration. A rhomb graben terminating near Salt Springs would have effectively constrained major subsidence and high rates of sedimentation to the Athol Syncline during the Westphalian B. The possibility that prerequisite conditions for peat mire development and preservation, such as a groundwater-fed piedmont (Calder, 1986), existed to the east of the Athol Syncline at that time would therefore be diminished.

Diapirism of Windsor Group evaporites and related strata has been cited as the chief factor in the origin of the Cumberland Basin coals (Shaw, 1951; Copeland, 1959; Hacquebard et al., 1967) and has been invoked by the latter workers to explain intra-seam depositional phenomena (Hacquebard et al., 1967). Much of the evidence cited by these workers in support of major diapir-related topographic relief during coal deposition has been disputed by the author (Calder, 1986). The possibility that incipient formation of the diapir in the subsurface, alluded to by Bell (1944), influenced subsidence and hence coal formation in the Springhill area is, however, both difficult to refute and entirely plausible. Evaporites in the Cumberland Basin may have flowed preferentially along basement faults, thereby increasing the potential influence of such a north-south fault east of Springhill.

Recent studies in southeastern New Brunswick by workers such as Nance and Warner (1986) document mid-Westphalian (A-C?) thrusting near the southwestern corner of the Cumberland "coal basin" (in order to avoid confusion with the larger Cumberland Basin, the names Athol Syncline or Athol Graben are preferred to the ambiguous "Cumberland coal basin"). This may well have served as the driving mechanism of the easterly to northeasterly flowing braided trunk river system (Salas, 1986) which deposited the upper conglomerates of the Cumberland Group in the western part of the Athol Syncline. Palynological samples taken during the 1986 field season along the Sand River - Spicers Cove section (Divisions X and XI of Fletcher, 1908) may assist in determining whether this easterly flowing braided system was contemporaneous with and possibly a more proximal expression of the longitudinal trunk braided-meandering fluvial transition (Calder, 1984) of the Springhill coalfield to the east. The recognition of a continuous trunk fluvial system would greatly enhance the understanding of the paleogeography throughout the Athol Syncline during the Westphalian B, facilitating a much clearer vision of where to explore for subsurface coal deposits west of the Springhill coalfield.

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OIL SHALES OF THE STELLARTON BASIN, NOVA SCOTIA*

R. D. Naylor and W. D. Smith

The Pennsylvanian coal-bearing Stellarton Group, situated within the Stellarton Basin (Fig. 1), contains Nova Scotia's best known oil shale deposit. This deposit has been the focus of interest as a potential source of hydrocarbons since the 1850s (Douglas and Campbell, 1942). Only limited attempts have been made to identify the number and lateral continuity of oil shale units within the group and to differentiate them into lithotypes (e.g. How, 1868; Bell, 1940; Haites, 1956; Macauley and Ball, 1984). This information is important to an assessment of their potential economic use. Consequently, a study of the oil shales incorporating geological field mapping, core-logging, organic and inorganic geochemistry and organic petrology was initiated by the Nova Scotia Department of Mines and Energy (NSDME) in 1984. The following is a partial summary of observations and analytical results to date.

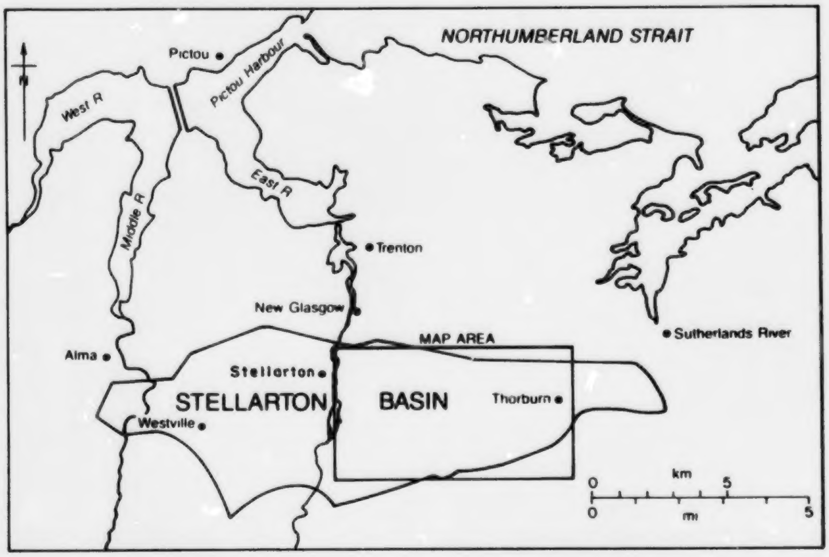
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Figure 1. Location map of the Stellarton Basin showing the map area for NSDME Open File Report 86-052.

A total of 45 laterally continuous oil shale units, averaging 5 m in thickness, have been identified within the Thorburn, Coal Brook and upper Albion Members of the Stellarton Group (Fig. 2). The oil shale units are silicate-rich (Naylor et al., 1986) and can be subdivided into lithotypes including carbonaceous shale, oil shales A, B and C and locally torbanite (Naylor et al., 1985). Each lithotype is characterized by distinctive

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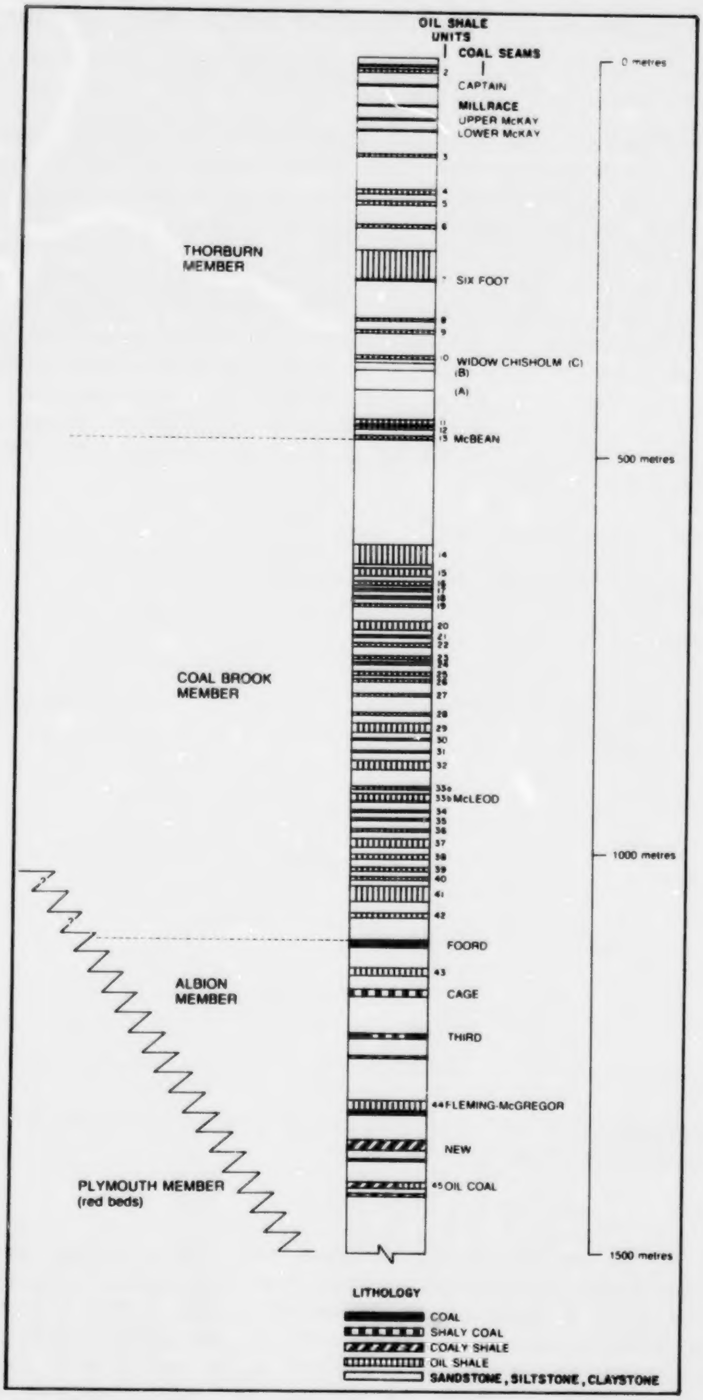
*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement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OIL SHALE
SANDSTONE, SILTSTONE, CLAYSTONE

Figure 2. Stratigraphic column from the east side of the Stellarton Basin. Member names and boundaries after Bell (1940).

megascopic properties (streak, fracture style, rock colour and appearance; Table 1). The lithotypes show increasing levels of organic content, chiefly exinitic organic matter, and decreasing specific gravity from carbonaceous shale through oil shales C-A to torbanite. Oil shale unit 45 contains stellarite, a friable, black, distinctly laminated and contorted oil shale lithotype. Stellarite is known only to this unit and analytical results are presently unavailable.

Coal seams locally pinch out laterally into units of oil shale (e.g. Six-Foot, McBean and McLeod seams) (Naylor et al., 1985; 1986). In vertical section coal/coaly shale is sharply overlain by cannel coal which grades upwards into oil shale C/B. In such coal to oil shale transitions, the overall organic carbon content of the lithotypes decreases (particularly humics) and the proportion of exinites in the organic component increases. Cannel coal is compositionally intermediate to coal and oil shale and is composed of about equal proportions of humics and exinites (Table 1). This coal to oil shale relationship suggests that a number of the other 42 oil shale units may be replaced laterally by coal seams and offers the potential for coal development in untested areas of the basin (Naylor et al., 1985; 1986).

Table 1. Lithotype classification scheme and results of the technical analyses summarized with respect to lithotype. SG = specific gravity, n = number of samples, n.d. = not determined and N/A = not applicable.

LITHOTYPE	COLOUR AND APPEARANCE	STREAK	AVE. S. G.	AVERAGE ORGANIC CONTENT	HYDROCARBONS		
					Average Conversion (%)	Average Yield (l/t)	Average s.g. of oil
Carbonaceous Shale (F_c)	Dark grey to black, local pale grey silty interbands. Contains siderite bands and nodules. Exhibits fissility	powdery, pale grey	2.66, n=8	3.40% TOC, n=8 2.9% Exinites 0.5% Humics	21.5, n=8	4.0, n=7	n.d.; insufficient oil yield for determination
Oil Shale C (O_C)	Dark grey to black, locally colour-banded dark grey and black. Exhibits sub-fissility.	waxy, dark grey	2.62, n=19	3.08% TOC, n=19 2.5% Exinites 0.6% Humics	29.8, n=19	6.7, n=18	0.868; light, n=2
Oil Shale B (O_B)	Black, exhibits sub-fissility	waxy, light brown	2.63, n=25	4.69% TOC, n=25 3.6% Exinites 1.1% Humics	29.7, n=25	10.7, n=23	0.887; light, n=8
Oil Shale A (O_A)	Black, exhibits sub-fissility.	waxy, dark brown	2.56, n=19	7.24% TOC, n=19 5.5% Exinites 1.7% Humics	33.3, n=19	16.0, n=12	0.886; light, n=11
Torbanite (O_{tbn})	Black with a bluish lustre, massive, tough, exhibits little fissility and a conchoidal fracture.	waxy, dark brown	2.16, n=6	21.00% TOC, n=6 18.3% Exinites 2.7% Humics	41.3, n=6	58.7, n=4	0.897; light, n=10
Cannel Coal (C_c)	Black with a greasy lustre, massive with local "coaly streaks", tough, exhibits a conchoidal fracture.	waxy, black	2.46, n=13	13.48% TOC, n=13 7.2% Exinites 6.3% Humics	24.5, n=13	17.8, n=9	0.895; light, n=4
Coal (C)	Black, micro-banded; dull, bright and dull-and bright-banded.	N/A	1.57, n=6	60.15% TOC, n=6 1.4% Exinites 58.8% Humics	23.8, n=6	83.9, n=3	0.994; heavy, n=3
Coaly Shale (C_f)	Black, thinly interbanded coal and shale; exhibits fissility.	N/A	2.20, n=4	15.65% TOC, n=5 Proportion of Exinites and Humics not determined	24.7, n=5	28.7, n=3	0.943; heavy, n=2

Light hydrocarbons are generated by pyrolysis in increasing amounts from carbonaceous shale through oil shale C-A to torbanite. High yields of heavy hydrocarbons are generated by pyrolysis of coaly shale and coal. Cannel coal gives moderate yields (intermediate to oil shale A and torbanite) of light hydrocarbons. Hydrocarbon yields show good correlation with megascopic lithotype and thus properties such as streak, fracture style and specific gravity can be used as a means of estimating hydrocarbon yield.

A report on the stratigraphy, lithology and composition of the Stellarton Group oil shales will be available in late 1986 as NSDME Open File Report 86-051. A related report on the stratigraphy and sedimentology of the Stellarton Group, including a geological map of the east half of the Stellarton Basin, as outlined in Figure 1, will also be available in late 1986, as NSDME Open File Report 86-052.

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MODELS FOR COAL EXPLORATION - TRENTON SYNCLINE AREA, NOVA SCOTIA*

*A. M. D'Orsay**, R. D. Naylor, W. D. Smith, M. C. Black, S. E. Palmer****

Within the Trenton Syncline (Fig. 1) the Merigomish Formation of the Pictou Group (Yeo, 1985) is underlain by a thick sequence of Cumberland Group conglomerates, namely the New Glasgow Conglomerate (Bell, 1940). The purpose of this project was to test the thin coals of the Merigomish Formation for trends in thickening and quality improvement, and to determine if coal measures occur distal to the Cumberland Group conglomerates as reported in the Cumberland Basin (Calder, 1983).

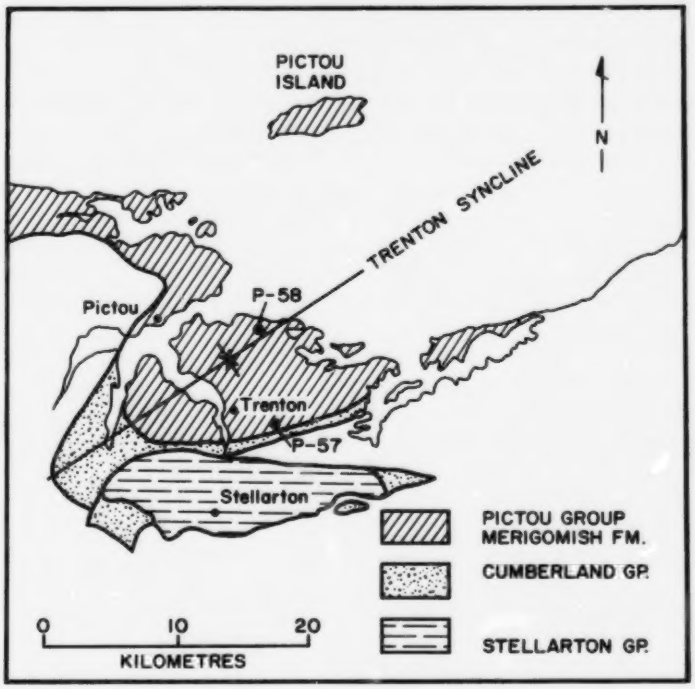
PICTOU ISLAND
N
TRENTON SYNCLINE
P-58
Pictou
Trenton
P-57
Stellarton
PICTOU GROUP MERIGOMISH FM.
CUMBERLAND GP.
STELLARTON GP.
0
10
20
KILOMETRES

Figure 1. Geological map of the Trenton Syncline area showing the location of drillholes P57 and P58.

Two holes were drilled, P57 (147 m) and P58 (845 m), as part of the project (Fig. 1). During deposition of the New Glasgow Conglomerate and the Merigomish Formation, sediment dispersal directions were northwards (Yeo, 1985). Therefore P58 was assumed to occupy a more favourable location for coal exploration due to its distal position relative to P57. Figure 2 presents a simplified illustration and correlation of the stratigraphy intersected in drillholes P57 and P58.

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*Funded by Nova Scotia Department of Mines and Energy and Geological Survey of Canada under the Canada - Nova Scotia Mineral Developemnt Agreement

**University of Western Ontario, London, Ontario

***Saint Mary's University, Halifax, Nova Scotia

No coal seams are present in either drillhole within the predominantly red New Glasgow Conglomerate. However, grey sandy beds, rooted zones and organic material become increasingly abundant near the base of drillhole P58. In P58, progradation of the New Glasgow Conglomerate is suggested by a coarsening and thickening upwards of conglomerate beds. In drillhole P57 the lowest stratigraphic member of the Merigomish Formation, the Smalls Brook Member, contains a basal stromatolitic limestone overlain by a grey lacustrine sequence of clastics and oil shales containing thin coals. In drillhole P58 the Smalls Brook Member is represented by a calcareous sandstone overlain by thin coals and rooted red mudstone, the latter of possible floodplain origin. The number, thickness and quality of the coal seams in P58 is reduced relative to P57. The Smalls Brook Member thins northerly, apparently the result of an erosional contact with the overlying Big Island Member (Fig. 2). The Big Island Member consists of a series of stacked channel sandstones of possible braided stream origin with intervening red and grey floodplain mudstones and siltstones. The Big Island Member, like the Smalls Brook Member, contains only a few thin coal seams.

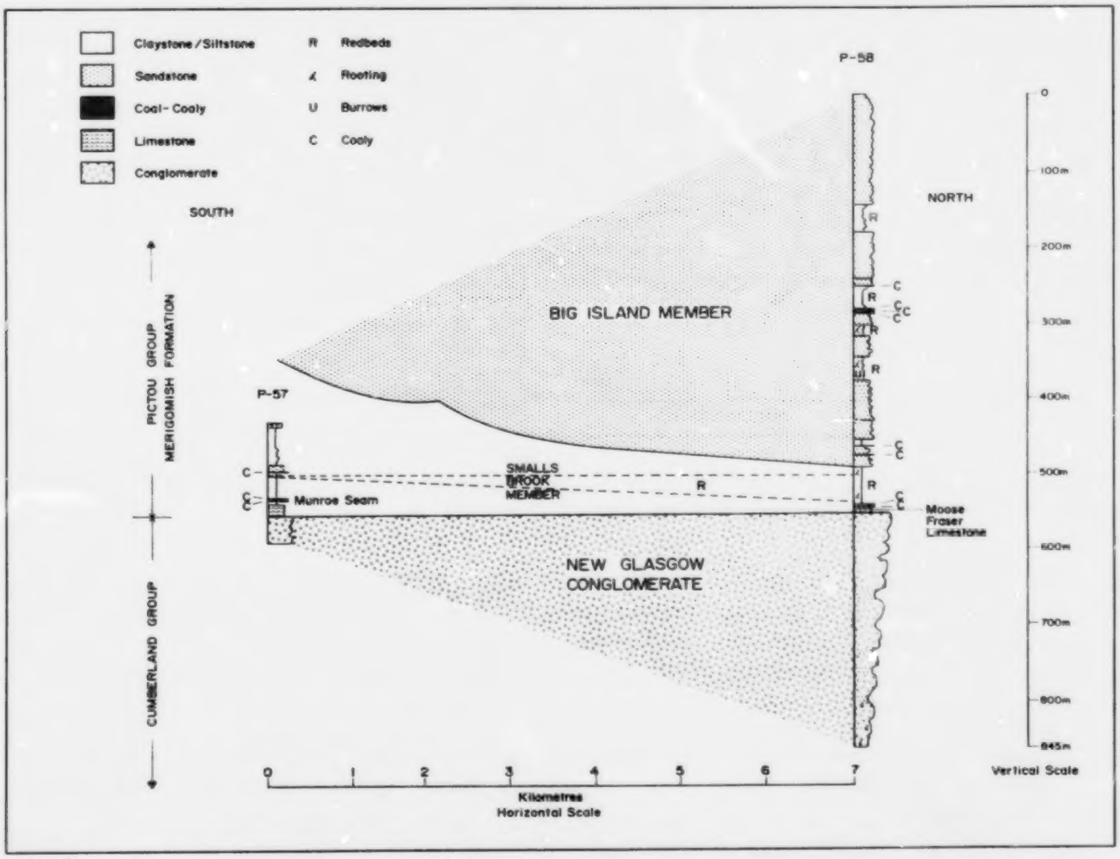
Claystone / Siltstone
Sandstone
Coal - Cooly
Limestone
Conglomerate
R Redbeds
Rooting
U Burrows
C Cooly
SOUTH
NORTH
P-57
P-58
PICTOU GROUP
MERIGOMISH FORMATION
CUMBERLAND GROUP
BIG ISLAND MEMBER
SMALLS BROOK MEMBER
NEW GLASGOW CONGLOMERATE
Munroe Seam
Moose Fraser Limestone
R
C
0
100m
200m
300m
400m
500m
600m
700m
800m
845m
Vertical Scale
0 1 2 3 4 5 6 7
Kilometres
Horizontal Scale

Figure 2. Stratigraphic correlation between drillholes P57 and P58, with the top of the New Glasgow Conglomerate used as a datum.

FUTURE COAL EXPLORATION - TRENTON SYNCLINE AREA

CUMBERLAND GROUP

The coarse grained nature of the Cumberland Group rock units intersected in drillhole P58, coupled with the regional northward sediment dispersal directions, indicate future exploration for Cumberland Group coal should be north of P58. A possible location for testing for Cumberland Group coal measures would be Pictou Island (Fig. 1). The Pictou Group strata overlying the Cumberland Group on Pictou Island are relatively thin, allowing possible coal measures of the Cumberland Group to be cored at a mineable depth.

MERIGOMISH FORMATION

Within the Merigomish Formation, in the Smalls Brook Member, thick high quality coal might exist between drillholes P57 and P58. The occurrence of such coal would require peat-forming marginal swamp conditions to have existed in the area between the lacustrine environment suggested in drillhole P57 and the floodplain environment indicated in drillhole P58. Coal seams may be present at higher stratigraphic levels within the Smalls Brook Member where it has not been as extensively eroded by the Big Island Member. Areas away from the axis of the Trenton Syncline, where the Big Island Member may thin, are potential targets for exploration.

The fluvial style of the Big Island Member is not conducive to the development or preservation of significant coal seams. Future coal exploration of the Big Island Member stratigraphic interval should concentrate on areas where a more mature fluvial system might have predominated.

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THE USE OF OIL SHALES AS A GUIDE TO COAL EXPLORATION AT THE EASTERN END OF THE STELLARTON BASIN*

R. D. Naylor, W. D. Smith and M. C. Black

Recent investigations of the oil shale- and coal-bearing Stellarton Group suggest that undiscovered coal may exist at depth on the east side of the Stellarton Basin. Within the upper two members of the Stellarton Group, the Thorburn and Coal Brook Members (Fig. 1), coal seams which are well developed at the basin margins often pinch out under an oil shale unit in central basin areas.

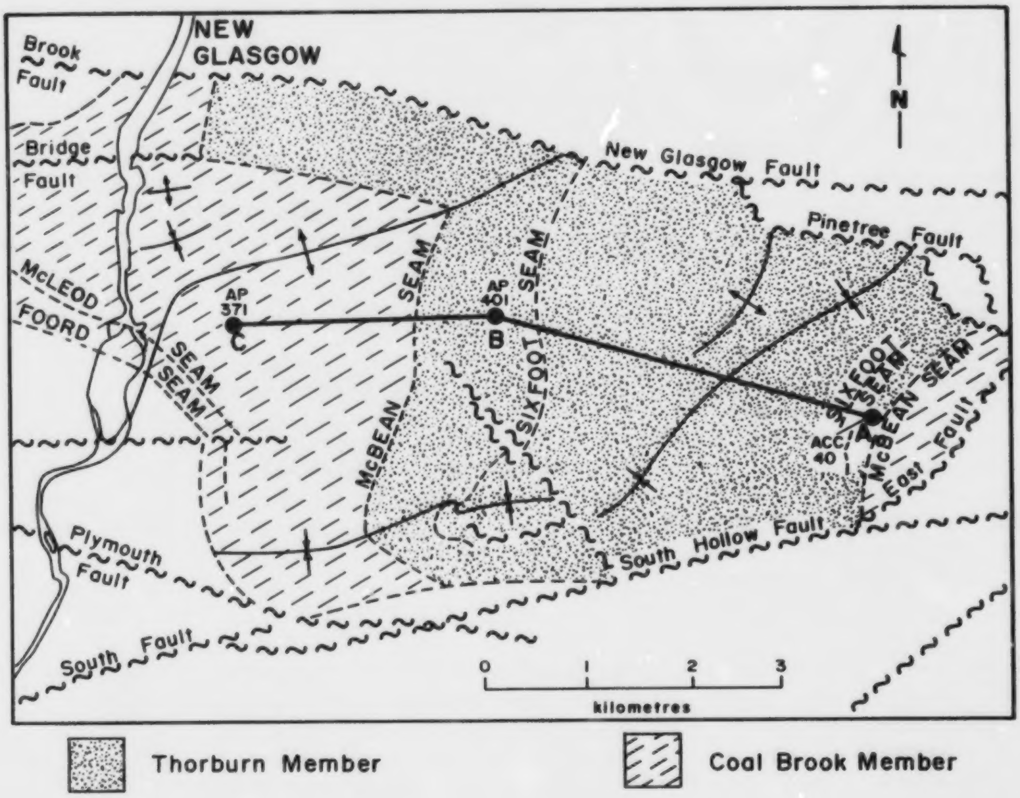
NEW GLASGOW
Brook Fault
Bridge Fault
N
New Glasgow Fault
Pinetree Fault
McLEOD SEAM
FOORD SEAM
AP 371
C
AP 401
B
SEAM
SEAM
McBEAN
SIXFOOT
SIXFOOT SEAM
McBEAN SEAM
A
ACC 40
East Fault
South Hollow Fault
Plymouth Fault
South Fault
0
1
2
3
kilometres
Thorburn Member
Coal Brook Member

Figure 1. Geological map of the eastern end of Stellarton Basin showing the location of sections A-B and B-C

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*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

Significant coal seams are known to directly underlie 3 of the 42 oil shale units of the Thorburn and Coal Brook Members. Section A - B (Fig. 2) illustrates that the Sixfoot and McBean seams (Thorburn Member) thicken eastward toward the basin margin but pinch out westward under oil shale units 7b and 13, respectively, toward the basin centre. Although the extensively mined Sixfoot and McBean seams can no longer be considered exploration targets, they serve to demonstrate that mineable coal seams occur under oil shale units toward the eastern margin of the Stellarton Basin.

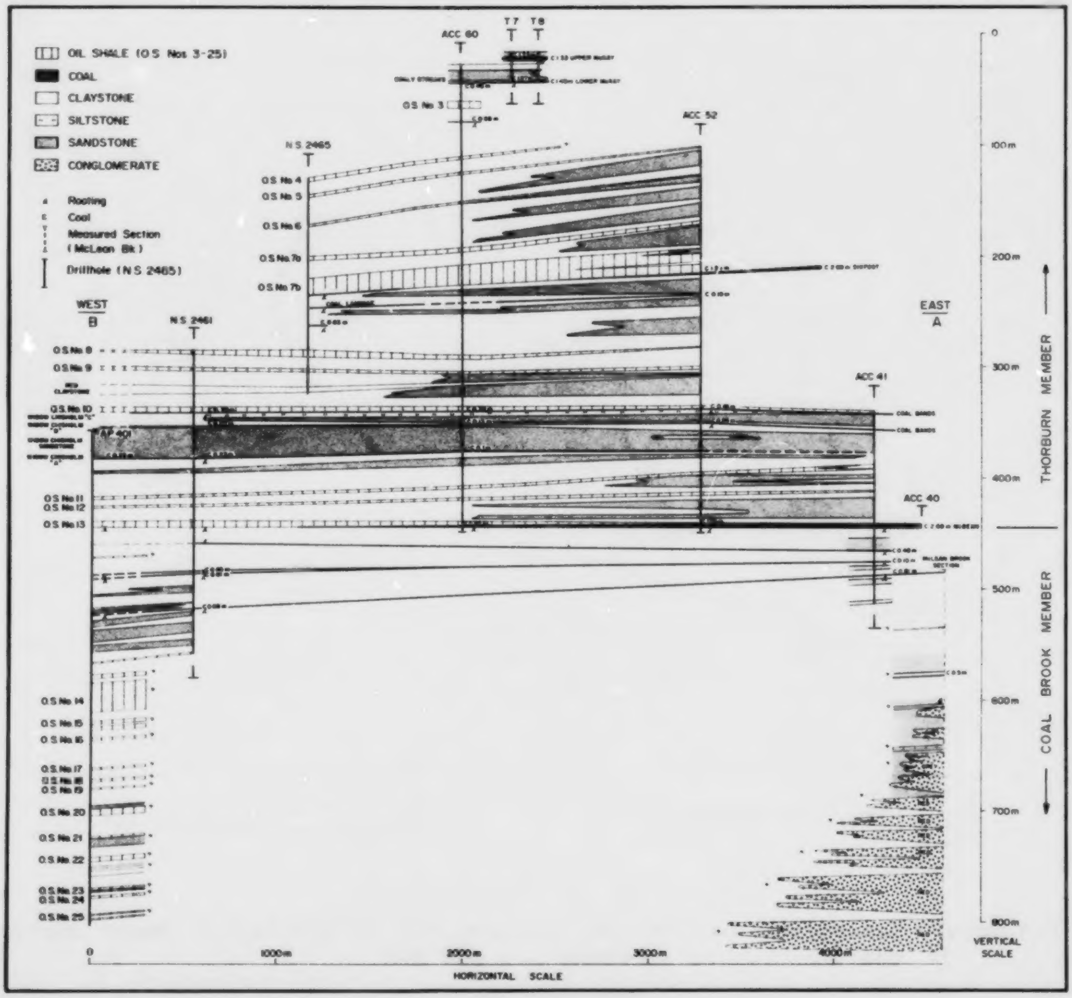
OIL SHALE (O.S. Nos 3-25)
COAL
CLAYSTONE
SILTSTONE
SANDSTONE
CONGLOMERATE
Rooting
Coal
Measured Section (McLean Bk.)
Drillhole (N.S. 2465)
WEST
B
EAST
A
ACC 60
T7
T8
N.S. 2465
N.S. 2461
ACC 52
ACC 41
ACC 40
AP 401
O.S. No. 3
O.S. No. 4
O.S. No. 5
O.S. No. 6
O.S. No. 7a
O.S. No. 7b
O.S. No. 8
O.S. No. 9
RED CLAYSTONE
O.S. No. 10
O.S. No. 11
O.S. No. 12
O.S. No. 13
O.S. No. 14
O.S. No. 15
O.S. No. 16
O.S. No. 17
O.S. No. 18
O.S. No. 19
O.S. No. 20
O.S. No. 21
O.S. No. 22
O.S. No. 23
O.S. No. 24
O.S. No. 25
SIXFOOT
McBEAN
COAL BANDS
McLEAN BROOK SECTION
0
100m
200m
300m
400m
500m
600m
700m
800m
VERTICAL SCALE
THORBURN MEMBER
COAL BROOK MEMBER
0
1000m
2000m
3000m
4000m
HORIZONTAL SCALE

Figure 2. Stratigraphic section (Section A - B) within Thorburn and Coal Brook Members using McBean seam as a datum.

The potential for finding additional significant coal underlying oil shale units within the Thorburn Member is limited as the majority of these oil shale units are laterally traceable to the eastern basin margin. In contrast, the potential for coal seams to have developed under the oil shale units of the Coal Brook Member has not been extensively tested. Section B - C (Fig. 3) illustrates that the McLeod seam, the only known coal seam of the Coal Brook Member, pinches out completely under oil shale unit 33 near the basin centre. To date, the McLeod seam has not been tested east of hole AP-401 (Figs. 2 and 3) for thickening and quality improvement trends. The McLeod seam holds excellent exploration potential if it continues to thicken to the east in a fashion similar to the Sixfoot and McBean seams. Also, the occurrence of rooted zones under a number of Coal Brook Member oil shale units in drillhole AP-401 suggests that coal may have developed eastward at these horizons near the basin margin.

In addition to the promising stratigraphic evidence, the interpreted paleogeography of the Coal Brook Member suggests that additional coal could have developed on the east side of the Stellarton Basin. During deposition of the Stellarton Group, lacustrine conditions predominated in the central Stellarton Basin with subordinate fluvial sedimentation occurring nearer the basin margins (Hacquebard and Donaldson, 1969). The distribution of coarser clastics, shown in Figures 2 and 3, strongly supports this interpretation.

The Stellarton Group oil shales are thought to have originated as hydrogen-rich organic material deposited in lakes (Macauley and Ball, 1984; Naylor et al., 1985) which were infilled largely by deltaic sediments (Naylor et al., 1985; 1986), namely the sandstone, siltstone and claystone of Figures 2 and 3. The coals underlying oil shales were probably formed on delta plain swamps which developed as the lakes were gradually infilled. During periods of restricted lake conditions algae and other hydrogen-rich organic material may have been deposited within the lakes while peat accumulated on the bordering delta plains. This suggests that coal seams and oil shales may have developed contemporaneously within the Stellarton Basin.

Detailed examination of Thorburn and Coal Brook Member coal to oil shale transitions shows that banded coal and coaly shale are abruptly overlain by cannel coal which is subsequently overlain by oil shale (Naylor and Smith, 1986). Interpretation of this vertical sequence indicates that increased infilling of lakes by sediment hindered basin drainage and resulted in subsequent flooding of the marginal swamps.

Based on the above, the development of significant coal seams below oil shale units east of drillhole AP-401 (Fig. 1) required that lakes remained restricted for long periods at the basin centre. The Sixfoot, McBean and McLeod seams provide evidence that such conditions did periodically exist during deposition of the Thorburn and Coal Brook Members.

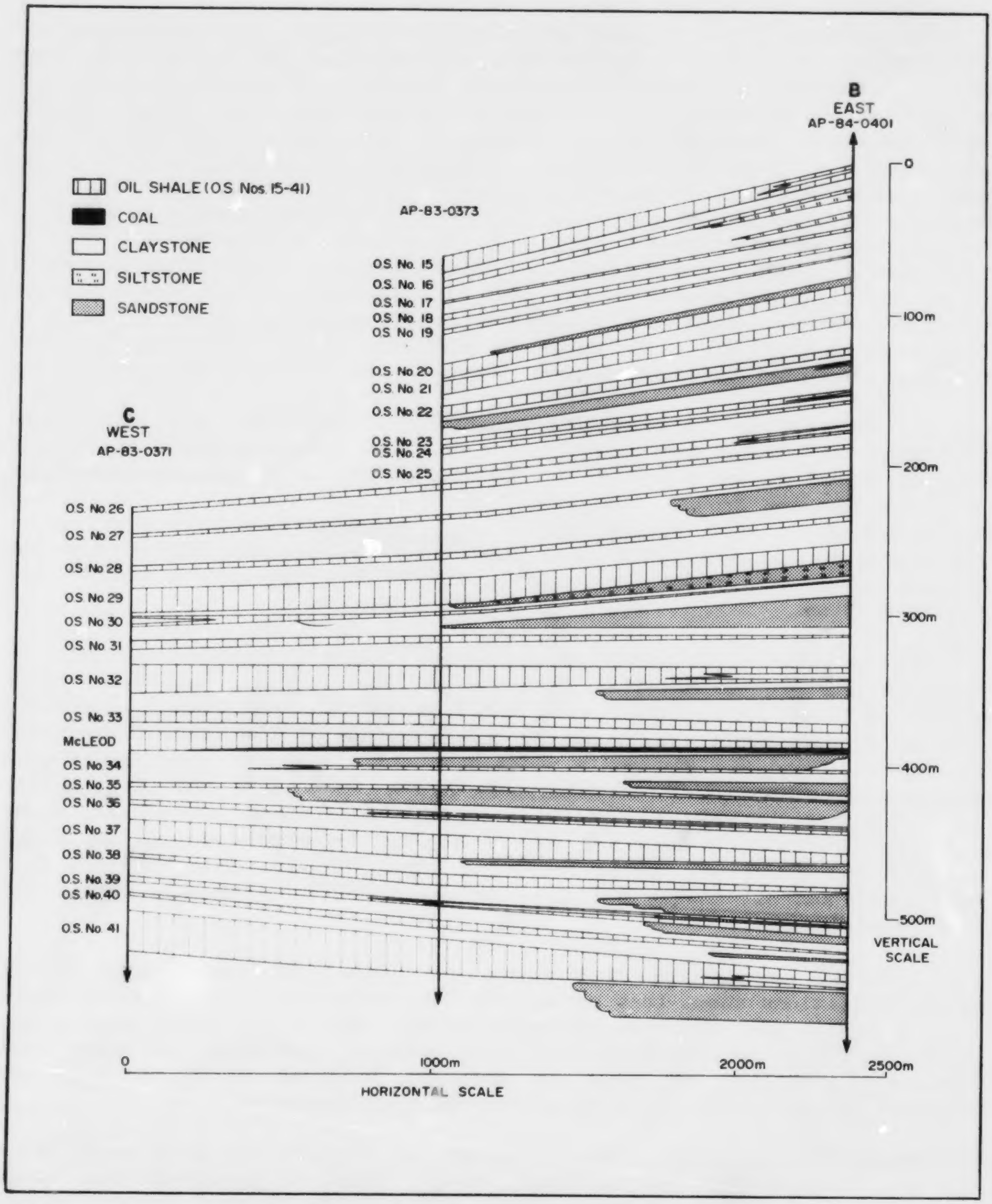
B
EAST
AP-84-0401
OIL SHALE (OS Nos. 15-41)
COAL
CLAYSTONE
SILTSTONE
SANDSTONE
AP-83-0373
C
WEST
AP-83-0371
O.S. No. 15
O.S. No. 16
O.S. No. 17
O.S. No. 18
O.S. No 19
O.S. No 20
O.S. No 21
O.S. No. 22
O.S. No 23
O.S. No 24
O.S. No 25
O.S. No 26
O.S. No 27
O.S. No 28
O.S. No 29
O.S. No 30
O.S. No 31
O.S. No 32
O.S. No 33
McLEOD
O.S. No 34
O.S. No 35
O.S. No 36
O.S. No 37
O.S. No 38
O.S. No 39
O.S. No 40
O.S. No 41
0
100m
200m
300m
400m
500m
VERTICAL SCALE
0
1000m
2000m
2500m
HORIZONTAL SCALE

Figure 3. Stratigraphic section (Section B - C) within the Coal Brook Member using McLeod seam as a datum.

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MINERAL EXPLORATION MONITORING

P. McCulloch

Monitoring of mineral exploration activity in the Province is carried out by the Resource Geology Section of the Mineral Development Division and is co-ordinated through the Stellarton regional office. The program of exploration monitoring includes regular visits to exploration and mining development sites as well as visits to company offices established in the Province. This provides a direct liaison with industry through which the Department is able to maintain an awareness of current exploration and development activities (Fig. 1). Other responsibilities include a review of current assessment reports submitted by industry, various statistical studies on exploration expenditures and claim holdings in the Province, and preparation of information packages of non-confidential information as requested by industry and the general public.

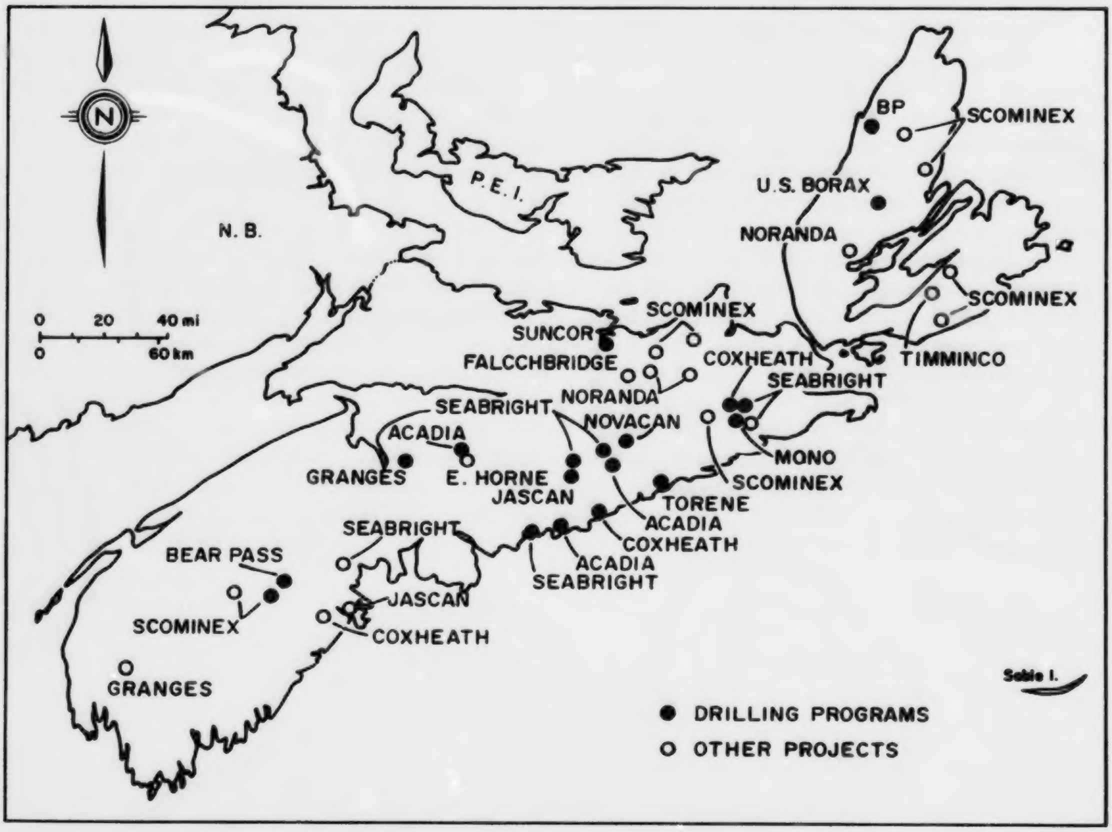
N
P.E.I.
N.B.
0 20 40 mi
0 60 km
BP
SCOMINEX
U.S. BORAX
NORANDA
SCOMINEX
TIMMINCO
SCOMINEX
SUNCOR
FALCCHBRIDGE
COXHEATH
SEABRIGHT
SEABRIGHT
NORANDA
NOVACAN
ACADIA
GRANGES
E. HORNE
JASCAN
MONO
SCOMINEX
TORENE
ACADIA
COXHEATH
SEABRIGHT
ACADIA
SEABRIGHT
BEAR PASS
SCOMINEX
JASCAN
COXHEATH
GRANGES
Sable I.
● DRILLING PROGRAMS
○ OTHER PROJECTS

Figure 1. Location of principal exploration programs in Nova Scotia - 1986.

At the present time all significant exploration and development projects are summarized on an annual basis for inclusion in reports to the Legislative Committee on Mines and Energy and for general in-house

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NSDME Information Series No. 12

reference as required. These summaries include an historical background on the property, current status and a brief summary of the current work program. Details of the projects are limited to the type of programs carried out, to ensure the confidential nature of the work.

An annual summary of mineral exploration and development in the Province is being considered for publication and would include an expanded version of the current in-house summary reports. The format would draw on similar publications currently being produced by other provinces and would include general statistics and a review of government projects related to mineral exploration. A brief outline of mineral exploration in the Province is included in the annual Report of Activities and the Annual Report published by the Nova Scotia Department of Mines and Energy. In addition, details on current mineral exploration are presented by Department geologists at the annual Open House and Review of Activities either through poster displays or presentations.

Exploration for gold continues to dominate exploration activities for metallic minerals in the Province, reflecting the emphasis on precious metals exploration throughout the country. Activities are focused primarily on the auriferous quartz veins of the folded Cambro-Ordovician metasedimentary rocks of the Meguma Group of mainland Nova Scotia. Exploration is also being directed to volcano-sedimentary environments in other areas of the Province.

Highlights of the current exploration activity are centred on the development work being carried out by Seabright Resources Incorporated at Forest Hill in Guysborough County and Beaver Dam in Halifax County. A 230 m exploration shaft has been completed at the Forest Hill property (Teasdale Mine) to facilitate a detailed underground examination of several auriferous vein systems outlined by diamond-drilling during 1984-85. A decline was also started on the Beaver Dam property in late August for underground testing of significant ore reserves outlined by extensive diamond-drilling completed in recent months. Underground bulk sampling at both the Forest Hill and Beaver Dam sites will be tested at the recently acquired Gays River mill near Halifax.

DRILL CORE LIBRARY*

J. M. McMullin and J. D. Langille

The Nova Scotia Department of Mines and Energy maintains core storage facilities at four locations: two at Stellarton, Pictou County, one at Debert, Colchester County and one at Malagawatch, Inverness County. All facilities are now full, and work is in progress to remedy this situation by reducing the volume of core in the permanent collection and by constructing an additional building at the main facility in the Stellarton Industrial Park. Both projects are funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement. Mr. Bill Palmer, project geologist and Mr. Donald Weir, mineral technician, initiated the program of core reduction in 1985 with the evaluation of a large collection of drill core from the Gays River area. A report including recommendations for disposal of some of this drill core is in the final stages of preparation. Attention is now being focused on a large collection of core from the Walton mine in order to dispose of low value core.

The majority of core is stored on pallets. Transfer of pallets to viewing areas is by propane powered fork-lift truck. Logs and location maps are not on file at the core library facilities, but are available for most drill core refered to in the assessment files at the Halifax and Stellarton office libraries. Sampling of core is by prior permission only and is restricted to previously unsampled core. No whole core sampling is permitted. Core splitters and diamond saws are available to cut samples and a binocular microscope and ultra-violet light are also available for visitors' use. Photographic apparatus is to be acquired this year so that core may be photographed. Fees are charged only for use of the diamond saws.

The facilities are not staffed on a full-time basis so visitors are advised to contact personnel of the Mineral Development Division at the Stellarton regional office (752-8429) at least one day prior to arrival, to arrange an appointment.

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*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

MEGUMA GOLD DISTRICTS COMPILATION MAPS

J. McMullin, G. Richardson and M. Stephen

A project begun in 1983 to compile information useful for gold exploration in the Meguma Group is now nearing completion. Final revisions and drafting are being made to the series of eight 1:100 000 map sheets and these resulting maps will be available before the end of the year as OFM 86-049 to OFM 86-056, inclusive.

The maps show bedrock geology and structure (with particular reference to anticlines and synclines in the Meguma Group), the NTS grid (topographic map boundaries and mineral tract boundaries), gold district boundaries, gold occurrences and prospects, anomalous gold values in lake sediments, Nova Scotia Department of Mines and Energy Mineral Occurrence Data card references, gold production figures and boundaries of detailed Faribault surface plans.

The maps used in OFR 371 (Regional Lake Sediment Geochemical Surveys for Eastern Mainland Nova Scotia) and OFR 453 (Regional Lake Sediment Geochemical Surveys for Southwestern Mainland Nova Scotia) provide the physiographic base maps for the compilation .

Each map is a tabulation of all occurrences and prospects corresponding to each map sheet. Reference notes including assessment file numbers and other map references are provided for each occurrence. A complete alphabetical tabulation of all occurrences with reference notes will be released separately as OFR 86-041.

GOLD INVENTORY PROJECT*

C. K. Miller

The Gold Inventory Project is a commodity study of precious metal occurrences in Nova Scotia and is funded under the Canada - Nova Scotia Mineral Development Agreement. The objective of the project is to produce a comprehensive review and compilation of the distribution and character of gold, silver and platinum-group metals in the Province. This project was begun in December 1984 and will conclude in September 1987.

A major component of the project has been a literature review of the thousands of technical papers, theses, newspaper articles, and government and private reports related to the subject. In addition to the literature review, several gold occurrences or prospects have been located and sampled.

During 1985, two diamond-drill holes measuring 335 m and 320 m in depth were completed near Sinclair Lake, south of Goldenville, Guysborough County. Both holes are interpreted to have penetrated the axis of the Wine Harbour Anticline at a point marked by a linear VLF-EM conductor and a coincident magnetic high. The dominant rock type is metagreywacke with a well developed pressure solution cleavage. The core is cut by quartz-calcite veins and stringers of all orientations. Veining is more extensive in the axial zone of the fold. Sections of intense cleavage development and veining in both drillholes have been altered and show enrichment in Pb, Zn, Cu, As, Sb and Ba. No gold was observed in any of the veins, but gold is enriched (340 ppb) in the metagreywacke on the south limb of the anticline. Additional drilling scheduled for late 1986 will further investigate the structure and mineralization in this area.

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*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

INDUSTRIAL MINERALS*

J. H. Fowler

General improvements in the North American economy have had a favourable impact on industrial mineral activities in Nova Scotia as evidenced by production increases for several commodities and new interest in many of the Province's undeveloped resources.

The current Canada - Nova Scotia Mineral Development Agreement, coinciding with this upswing in the economy, is providing funds at a most opportune time, allowing the Nova Scotia Department of Mines and Energy, and Energy, Mines and Resources Canada to undertake several industrial mineral programs designed to promote resource development in Nova Scotia. Programs underway include commodity market studies, mineral technology programs and mineral resource evaluation projects.

Six mineral resource evaluation programs are now underway and are the responsibility of the Mineral Development Division, Nova Scotia Department of Mines and Energy. The design and terms of reference for the commodity studies and mineral technology programs were developed by the Nova Scotia Department of Mines and Energy, and Energy, Mines and Resources Canada (EMR). Mineral Policy Sector of EMR is the lead agency responsible for market studies and Canmet of EMR assumes a similar role with respect to mineral technology programs.

MINERAL RESOURCE PROJECTS - 1986

The objective of the resource studies is to create an awareness of the Province's industrial mineral resources and to promote resource development and production diversification. Programs underway include (a) a project to identify and promote the development of the building stone resources of the Province, (b) a program to document the gypsum and anhydrite resources of Nova Scotia, (c) an aggregate resource mapping project in selected regions of the Province, (d) a program to evaluate the Province's diatomite resources, (e) a filler and extender market and resource evaluation study and (f) an evaluation and information database collection of many of the Province's lesser known industrial minerals. These programs are described in the following pages.

MARKET STUDIES - 1986

The following market studies are now available as Open File Reports (OFR) from the Nova Scotia Department of Mines and Energy (NSDME):

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*Funded by Nova Scotia Department of Mines and Energy, and Mineral Policy Sector and Canmet of Energy, Mines and Resources Canada under the Canada - Nova Scotia Mineral Development Agreement

1. **The Gypsum Industry in Nova Scotia, Present Status and Future Prospects,** NSDME OFR 752

   This report was prepared by the Centre for Resource Studies, Queens University and describes the current status of the gypsum industry in Nova Scotia and identifies future employment and resource generating opportunities.

2. **Study of Markets for Aggregate Materials Accessible from Nova Scotia and New Brunswick,** NSDME OFR 86-010

   This report was prepared by ADI Limited and describes the current market for aggregates accessible from New Brunswick and Nova Scotia. The report also provides a forecast of market potential to the year 2005 and an identification of other relevant factors which could influence aggregate marketing.

3. **A Study of Industrial Minerals Used in Oil and Gas Exploration on the Eastern Canadian Offshore,** NSDME OFR 86-012

   This report was prepared by Jacques, Whitford and Associates and Cleland, Dunsmuir Consulting Limited to examine the use of industrial minerals within the Oil and Gas Exploration Industry on the east coast of Canada.

4. **Study of Markets for Silica and Silica Sands Accessible from Nova Scotia and New Brunswick,** NSDME OFR 86-013

   This report was prepared by ADI Limited to determine and quantify markets for silica and silica sands reasonably accessible from Nova Scotia and New Brunswick.

5. **Agricultural Gypsum Project,** NSDME OFR 86-039

   This report, prepared by P. Luke of Nova Scotia Department of Mines and Energy, is designed to promote the use of Nova Scotia gypsum as an agricultural fertilizer and as a soil amendment, for local markets and in the northeastern United States.

MINERAL TECHNOLOGY STUDIES - 1986

The following studies are currently in progress:

1. **Development of Engineering Data on Nova Scotia Fly Ash.** This study will provide comprehensive engineering data to identify more extensive uses of fly ash in the concrete industry. The contract for this study was awarded to L. E. Shaw Limited.

2. **Evaluation of the Pine Brook, Richmond County, Barite Deposit.** The study includes grinding and gravity separation tests on a bulk sample of barite ore from the Pine Brook deposit.

INDUSTRIAL MINERAL COMMODITIES MAP
MAP 85-1

A new Industrial Mineral Commodities Map for the Province of Nova Scotia (NSDME Map 85-1), compiled by J. H. Fowler, was released in 1986. This map locates industrial mineral deposits and occurrences of the Province, and also shows the location of present and past industrial mineral production operations.

GYPSUM/ANHYDRITE PROJECT*

G. C. Adams

Three goals have been established for the Gypsum/Anhydrite Project. The primary goal is to produce a comprehensive mineral inventory of the gypsum and anhydrite resources of Nova Scotia. The second is to increase and enhance relations between the Department and the Province's present producers and the third is to initiate and encourage development of alternative utilization of Nova Scotia's gypsum and anhydrite resources.

During the 1986 field season gypsum occurrences in Cape Breton, Richmond and Inverness Counties on Cape Breton Island, and in Hants County on the mainland were mapped and sampled (Fig. 1). Over two hundred samples were taken from as many occurrences and these samples have been analyzed for gypsum, anhydrite and salt content.

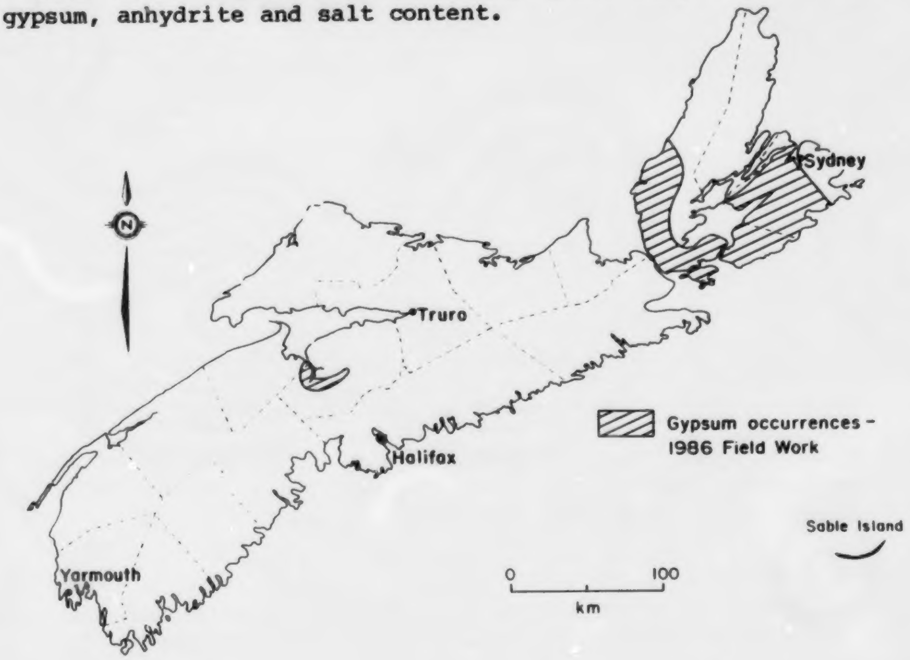

Figure 1. Gypsum anhydrite project fieldwork.

In addition, a small drilling program was undertaken to investigate the potential for extractable reserves of gypsum and anhydrite in the Sydney Basin. This program was proposed on the basis of drilling results by Morton Chemicals in 1960 and 1961, and Nova Scotia Department of Mines and Energy in 1984. These results indicated that gently dipping sulphate beds appear to be continuous both laterally and down dip in the Meadows Road Formation of the Windsor Group in the Meadows Road area of the Sydney

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*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

Basin (Fig. 2). Results, although still preliminary, reveal good reserves of both gypsum and anhydrite amenable to underground mining within the industrial Cape Breton area.

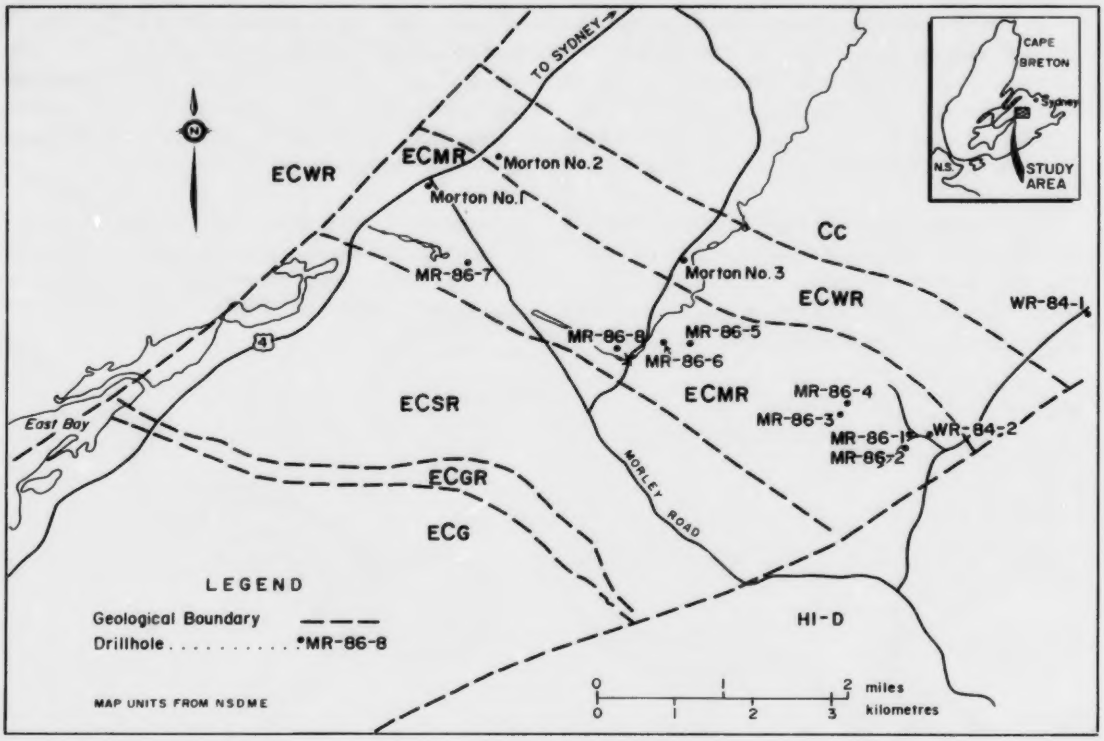
TO SYDNEY
N
ECWR
ECMR
Morton No. 2
Morton No. 1
CC
MR-86-7
Morton No. 3
ECWR
WR-84-1
MR-86-8
MR-86-5
MR-86-6
4
ECSR
ECMR
MR-86-4
MR-86-3
East Bay
MR-86-1
WR-84-2
MR-86-2
ECGR
MORLEY ROAD
ECG
HI-D
CAPE BRETON
Sydney
N.S.
STUDY AREA
LEGEND
Geological Boundary
Drillhole MR-86-8
MAP UNITS FROM NSDME
0
1
2
miles
0
1
2
3
kilometres

Figure 2. Meadows Road Drilling Program (map units from NSDME Map 86-1, Geological Map of the Sydney Basin, Cape Breton Island, Nova Scotia by R. C. Boehner and P. S. Giles).

The development of relations between gypsum companies and the Department is an ongoing process. To date two of the Province's five major producers have allowed access to geological and technical information on deposits which they own in fee simple or for which they hold gypsum rights. Assistance, when requested, has been provided to all gypsum producers.

Several topics have thus far been investigated under the heading of alternate utilization of Nova Scotia's gypsum and anhydrite resources. A study on the market potential for agricultural gypsum by P. Luke of Nova Scotia Department of Mines and Energy was completed in 1986 and is available as NSDME OFR 86-039. Ongoing studies at McGill University into coal mine roadside packing systems including anhydrite may help to encourage its utilization here in Nova Scotia and elsewhere in North America, as it has been used in West Germany for more than 15 years. Other investigations are currently underway and results will be reported at a later date.

GRANULAR AGGREGATE RESOURCES OF NORTHERN NOVA SCOTIA*

G. Prime

The aggregate industry of Nova Scotia ranks as the second most valuable mining activity in the Province in terms of product value and employment. As a result of its importance, there has been a substantial effort on the part of the Province to provide a comprehensive evaluation of these resources (e.g. Fowler, 1981; Fowler and Dickie, 1977, 1978; Wright, 1981, 1982, in press). This project represents a continuation of this task.

The study, initiated in June 1986, consists of a detailed examination of the granular aggregate in Cumberland and Colchester Counties (Fig. 1). The main objectives of the program are to document the occurrences of sand and gravel, to assess their quality and to identify new reserves. The end product of the project will be a report and map (scale 1:125 000).
Leave 33 lines for Fig. 1

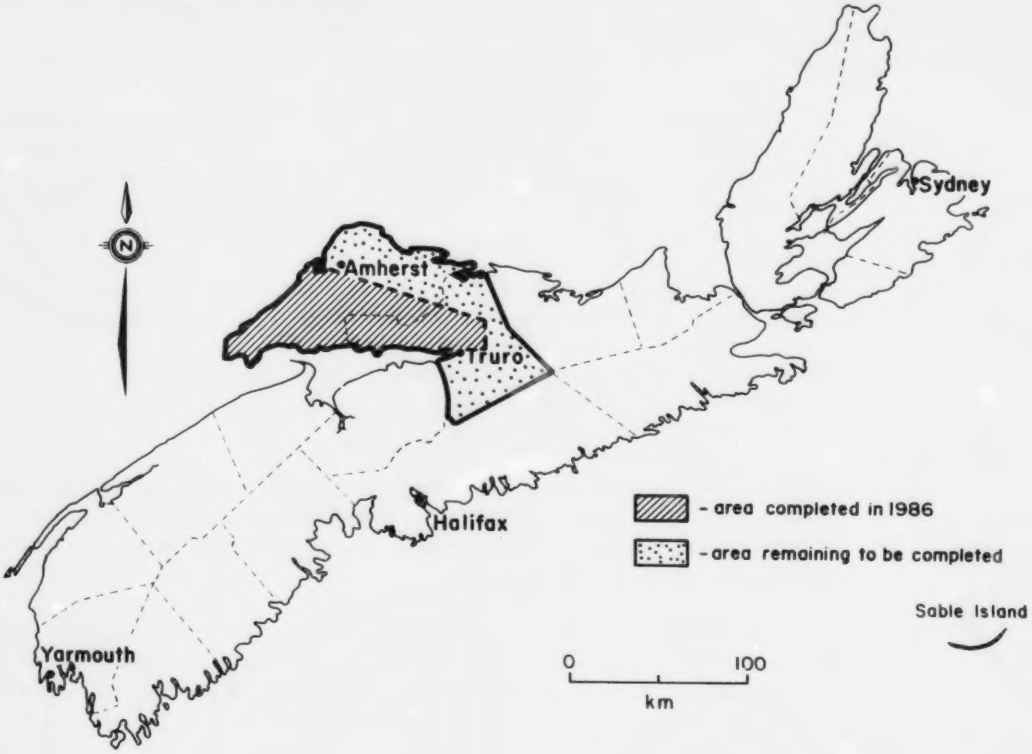
N
Amherst
Truro
Sydney
Halifax
Yarmouth
▨ - area completed in 1986
░ - area remaining to be completed
Sable Island
0
100
km

Figure 1. Location of study area.

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*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

The initial stage includes surficial mapping of the area and examination of all exposures and detailed descriptions of all pits. Aerial photographs and diamond-drill logs aid in the accurate delineation of the deposits. Based on the mapping results, a selective sampling program will be performed. The samples will be analyzed for size gradation, roundness, abrasion, petrographic composition and organic content. In the interest of identifying new reserves, selected areas will be examined in more detail with seismic profiling.

With the assistance of B. Cochrane, approximately 50 per cent of the necessary field mapping was accomplished during the current field season (Fig. 1). Preliminary results indicate that the aggregate deposits in the area are primarily of glacio-fluvial and ice-contact origin. Furthermore, the quality of the deposits appears to improve near or on the Cobequid Highlands, reflecting a greater influence from this source area. Finally there is an abundance of mechanically and chemically weathered conglomerate in the area which is being examined as a potential source of aggregate. This is of interest because of the general unconsolidated state, high quality petrographic composition and relative thickness (up to 6 m).

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FILLER AND EXTENDER MINERALS IN NOVA SCOTIA*

P. Lake

Mineral fillers and extenders are finely ground, generally inert substances used in the manufacturing of many products to reduce the consumption of more costly raw materials and to retain or enhance the physical characteristics of the product. At present no mineral resources in Nova Scotia are being mined for filler application.

A market analysis to identify users of mineral fillers and extenders in the Atlantic Provinces was initiated in July 1986. Companies which manufacture paint, paper, plastics, rubber products and carpets, and use mineral fillers such as talc, limestone, kaolin or barite have been identified and are currently being contacted to determine the quantity and quality of the fillers used.

Detailed studies on several known occurrences of limestone, diatomite and other minerals with potential filler use will commence in the spring of 1987. Deposits deemed to be of filler grade will be promoted extensively.

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*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

DIATOMACEOUS EARTH PROJECT*

A. R. (Sandy) Anderson

INTRODUCTION

Diatomaceous earth or "diatomite" is a siliceous sedimentary material commonly found in lakes and bogs in the upper reaches of many watersheds throughout Nova Scotia. This commodity is formed by the accumulation of the skeletal remains or shells of tiny one celled plants known as diatoms. Diatomaceous earth is essentially composed of hydrous silica ($SiO_2.nH_2O$) and is characterized by low specific gravity, large surface area and high porosity.

Although the vast majority of finished diatomite (545 000 tonnes) is used annually as a filter aid, 41 to 45 thousand tonnes of diatomite are used as a filler or extender in the paint, plastics and paper industries. Diatomaceous earth can also be used as an absorbent, chemical carrier, insulator and as an additive for Portland cement.

Diatomaceous earth was mined at several locations in Nova Scotia from 1928 to 1952, however 11 800 tonnes of semiprocessed diatomite was produced from three sites of Little River in Digby County, and Oxford and New Annan in Colchester County. The product was used as a mild abrasive in insulating firebrick and as a filler in rubber products. As markets changed and production of high quality, low cost diatomite and replacement fillers came on the market, production in Nova Scotia ceased. However, new uses and expanding markets now exist for diatomite.

PROGRAM ACTIVITIES 1986-1987

Literature research has established 115 occurrences of diatomite in Nova Scotia (Fig. 1) ranging from 5 to 10 cm to 3.5 to 4.5 m in thickness and as much as 20 to 30 hectares in area (most less than 10 hectares). Twenty-one deposits with the most potential were sampled during the past field season, employing 120 sample sites and providing 240 samples of 1-2 kg of diatomaceous sediment (Table 1). Samples were collected using a 50 cm MacAulay auger and a 1 m Hiller auger, which also provided additional deposit information.

Diatomaceous earth found in the lakes and bogs of Nova Scotia varied from a whitish grey, dense, compacted, silt-like sediment to a dark grey-brown, somewhat amorphous, semigelatinous ooze. The latter was commonly found in peatlands and was generally uniform in texture, with underlying layers of denser, pale grey-brown diatomaceous earth. Variations in diatomaceous earth colour and texture were extreme in lakes. Dense, white, orange or green stained sediments, 10 to 50 cm thick, were commonly found in shallow water (<2 m) while in deeper water softer, grey diatomaceous earth occurred in layers up to 3 to 4 m thick.

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*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

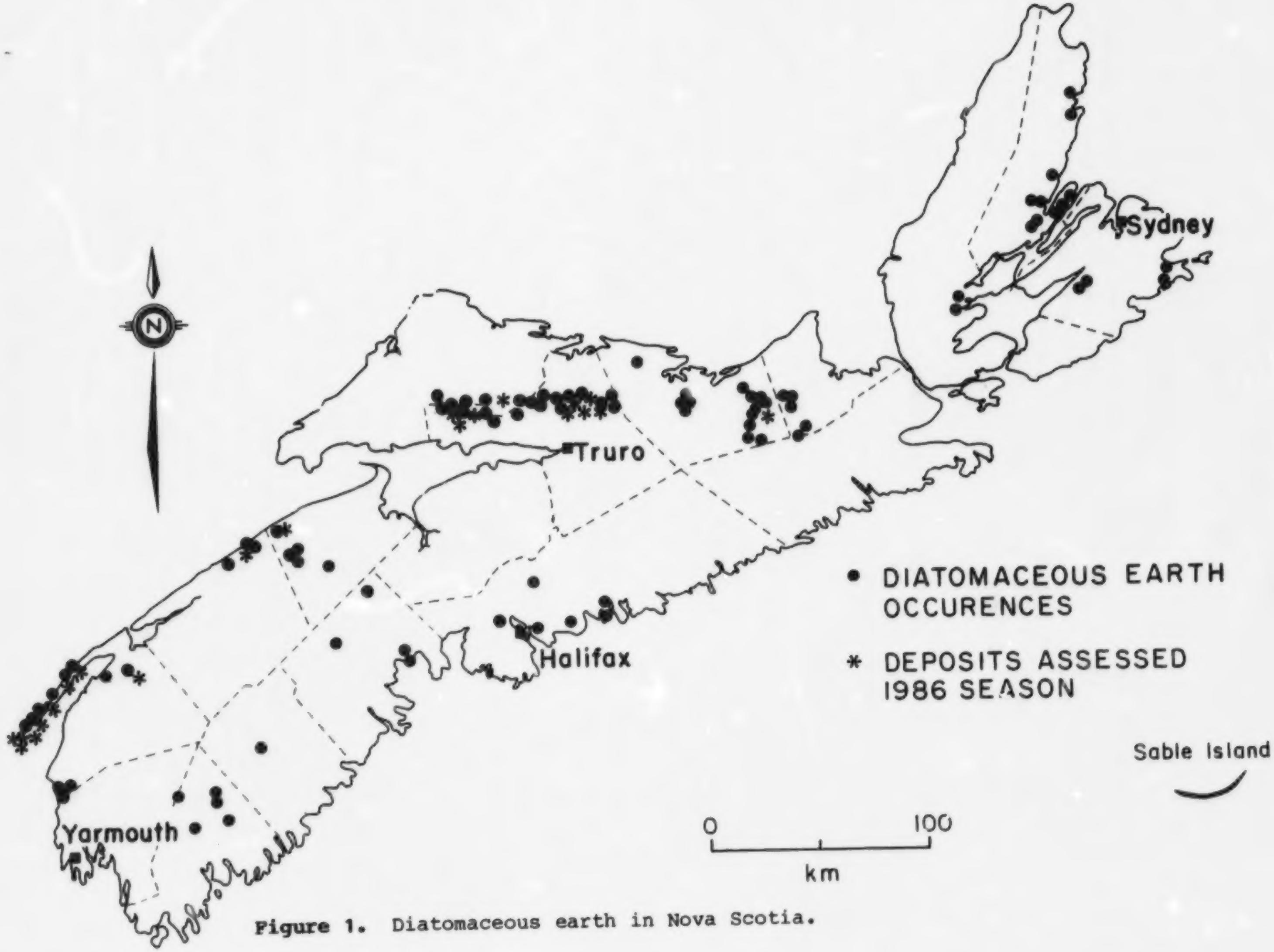
N
Sydney
Truro
Halifax
Yarmouth
● DIATOMACEOUS EARTH OCCURENCES
* DEPOSITS ASSESSED 1986 SEASON
Sable Island
0
100
km

Figure 1. Diatomaceous earth in Nova Scotia.

Table 1. Diatomacous Earth Samples, 1986

Location	Sites	Samples
Lake Bottom Sediments		
Broza Lake, Pictou County	11	51
Harris Lake, Digby County	5	9
Factory Bog, Digby County	14	60
Silica Lake, Colchester County	6	14
Clear Lake, Colchester County	11	25
Trout Lake, Colchester County	12	32
Lily Pond, Colchester County	3	13
Bass River Silica Lake, Colchester County	3	3
Isaacs Lake, Cumberland County	4	2
Peatland Bottom Samples		
Stillwater Bog - No. 3, Colchester County	1	3
Stillwater Bog, Colchester County	1	8
Stillwater Bog - No. 2, Colchester County	1	7
Bear River, Digby County	9	11
Central Grove, Digby County	7	22
Bog No. 5, Digby County	2	0
Bog No. 6, Digby County	1	4
Bog No. 9, Digby County	3	3
Small Property Bog, Digby County	3	3
Brier Island - No. 1, Digby County	4	0
Brier Island - No. 2, Digby County	4	0
Fundy Cranberry Bog, Annapolis County	3	0

Samples collected are being analyzed to assess the quality and potential of the resource. Initially, whole rock analysis, particle size distribution, and total organics and moisture content will be determined for each sample. Colour, hardness, brightness and absorbency will be determined for a subset of the most promising diatomaceous earth samples.

BUILDING STONE PROJECT*

G. B. Dickie

The Building Stone Project was initiated in September 1985 as a five year Canada - Nova Scotia Mineral Development Agreement program to identify, evaluate and prepare technical and promotional material on the stone resources of Nova Scotia for the purpose of identifying and encouraging the orderly development of these resources. The program will be carried out in a number of phases, beginning with an initial evaluation of past-producing quarries and followed by detailed studies, including diamond-drilling and quality testing on the most promising deposits. The identification of new building stone deposits will be a significant part of the program.

Stone has been used for building construction in Nova Scotia since the late 17th and early 18th centuries. The first stone used was probably imported ballast, while after the early 1800s a flourishing domestic industry provided mainly sandstone for both local and export markets. As many as 75 sandstone quarries produced stone in the mid 1800s for a total recorded production of over 1.1 million tons in the period 1873 to 1973.

The 1985-86 field program consisted of site visits to over 75 past-producing sandstone quarries (Fig. 1). Geological mapping and sampling was carried out at each site. Five of the best quarries were selected for diamond-drilling, which began in early 1986. Twenty holes totalling 687 metres were drilled at the following locations: Amherst, Cumberland County; Sawmill Brook, Pictou County; Eight Mile Brook, Pictou County; McKeen Quarry, Pictou County; and Judique, Inverness County. An excellent deposit of light grey, fine grained sandstone was outlined at Eight Mile Brook and the Amherst red sandstone deposit was further extended well beyond the present quarry boundaries. Quality testing will be conducted on the drill core this year and will evaluate parameters such as compressive strength, absorption, acid resistance, chemical composition, iron content and others.

A catalogue of all stone buildings in Nova Scotia is being prepared by D. Wilkinson. It will include information such as year of construction, builder, architect, present ownership, stone type and original quarry source for most buildings in the Province, compiled through archival research and site field visits. A report on the sandstones of Nova Scotia will be ready for publication by the middle of 1987.

Preliminary field investigations of granite quarries is currently in progress. In addition a reconnaissance of the granites of the Cape Breton Highlands will be completed this fall. It is possible that some of the coloured granites of Cape Breton may be suitable for cladding panels, curbing and monument stone.

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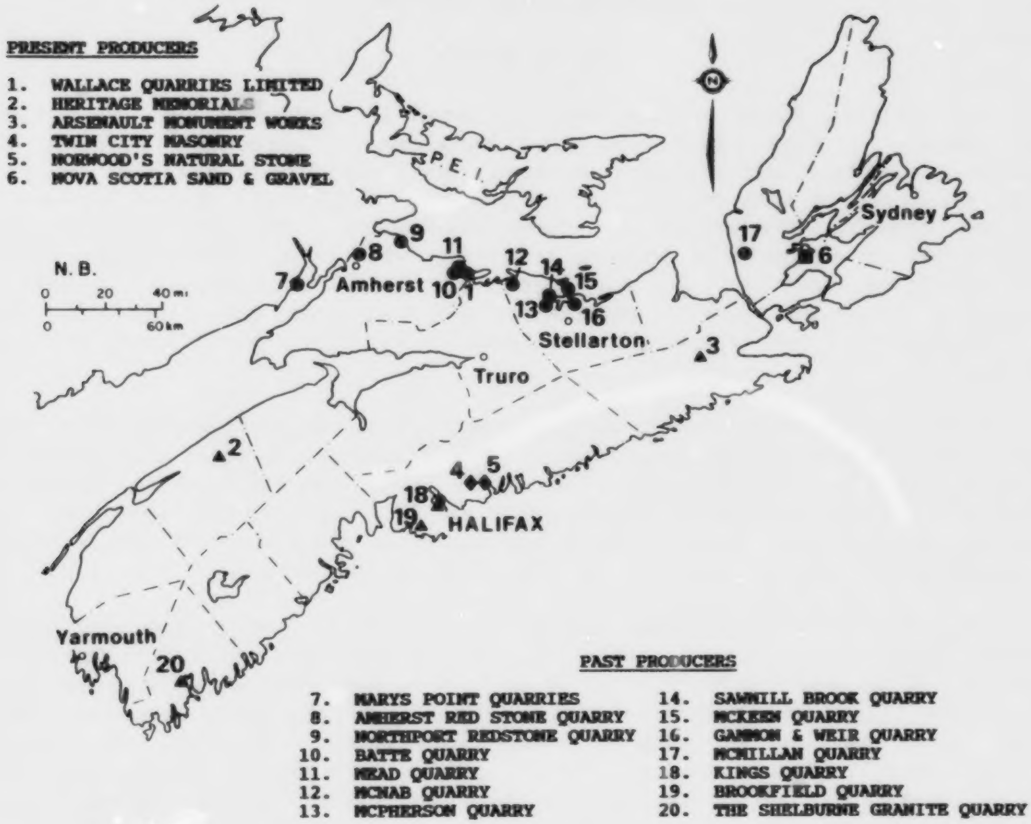
*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement


PRESENT PRODUCERS
1. WALLACE QUARRIES LIMITED
2. HERITAGE MEMORIALS
3. ARSENAULT MONUMENT WORKS
4. TWIN CITY MASONRY
5. NORWOOD'S NATURAL STONE
6. NOVA SCOTIA SAND & GRAVEL
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P.E.I.
N.B.
0 20 40 mi
0 60 km
Sydney
Amherst
Stellarton
Truro
HALIFAX
Yarmouth
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4
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PAST PRODUCERS
7. MARYS POINT QUARRIES
8. AMHERST RED STONE QUARRY
9. NORTHPORT REDSTONE QUARRY
10. BATTE QUARRY
11. MEAD QUARRY
12. MCNAB QUARRY
13. MCPHERSON QUARRY
14. SAWMILL BROOK QUARRY
15. MCKEEN QUARRY
16. GAMMON & WEIR QUARRY
17. MCMILLAN QUARRY
18. KINGS QUARRY
19. BROOKFIELD QUARRY
20. THE SHELBURNE GRANITE QUARRY

Figure 1. Present and major past stone quarries. Legend: solid triangle - granite; solid circle - sandstone; solid square - marble; solid diamond - other.

VARIOUS COMMODITIES PROJECT*

R. MacDonald

A Various Industrial Mineral Commodities Project was initiated in May 1986 to update and improve the database on several industrial mineral commodities which occur throughout the Province and are sought after in the market place. These commodities include andalusite, barite, beryl, brucite, dolomite, garnet, graphite, limestone, manganese, silica, spodumene, topaz, wollastonite and others that may surface as market demands change. Initial emphasis has been placed on the industrial mineral commodities which are presently most sought after in the market place. These include limestone and dolomite deposits and to a lesser degree graphite, silica, celestite and manganese deposits.

Most of the work to date has concentrated on data compilation and field investigations of limestone and dolomite deposits. Requests for assistance in locating additional resources have been made by users presently established within Nova Scotia as well as others investigating the possibility of utilizing provincial resources. During the past field season, 140 limestone and dolomite deposits were investigated and the most promising of these were sampled and assayed. The present demand is for high calcium limestone deposits near existing user facilities and for large tonnage specialized dolomite deposits at or near deep water shipping points.

A program of data compilation and field investigation has also been established for the other industrial mineral commodities previously mentioned. Figure 1 illustrates the major deposits that have been investigated during the 1986 field season. These deposits include:

1. Chegoggin Pt.-Lake George high grade silica and garnet deposits;
2. limestone/dolomite deposits of Glencoe, Kewstoke, Glendale, Churchview, Kellys Cove, Cape Dauphin, Ingonish, Admiral Rock, Brookfield and Meander River areas;
3 an alumina deposit at Dorts Cove, Guysborough County;
4. talc occurrences at Landing Cove and Stirling, Cape Breton Island;
5. spodumene and beryl deposits in southwestern Nova Scotia; and
6. various graphite, wollastonite, manganese, celestite and ilmenite occurrences.

Topaz, a by-product of Rio Algom's tin operation at East Kemptville, has been sampled and assayed with the hope of finding a suitable market for this product.

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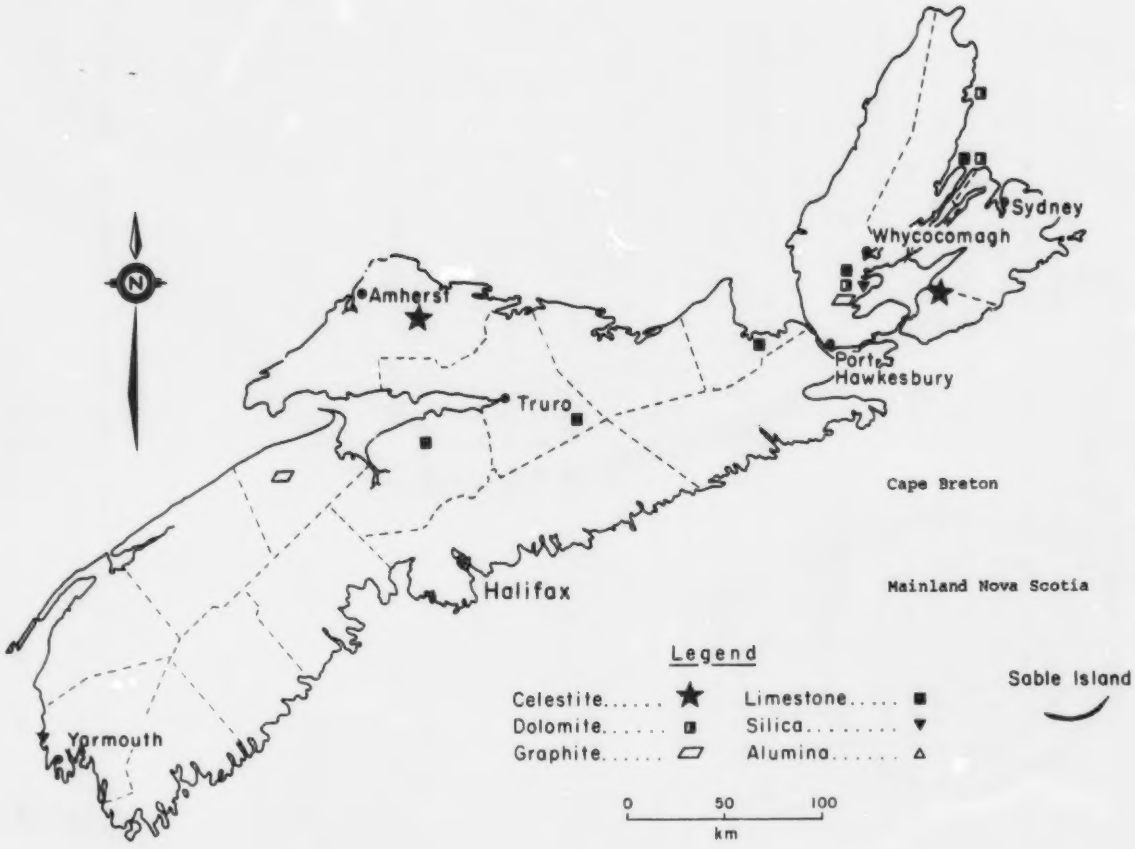
*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement


N
Amherst
Truro
Halifax
Yarmouth
Whycocomagh
Sydney
Port Hawkesbury
Sable Island
Legend
Celestite...... ★
Dolomite...... ◪
Graphite...... ▱
Limestone..... ■
Silica........ ▼
Alumina...... △
0
50
100
km

MAJOR DEPOSITS

Cape Breton	limestone	694	million tonnes
	dolomite	42	million tonnes
	celestite	.7	million tonnes
	silica	6.4	million tonnes
Mainland Nova Scotia	alumina	80	million tonnes
	limestone	large	tonnage potential
	silica	18	million tonnes
	celestite	910	tonnes

Figure 1. Major deposits included in the 1986 program.

MINERAL INVENTORY

N. A. Lyttle

BIBLIOGRAPHIC DATABASE ACTIVITIES*

(J. Gillespie-Wood, D. Wilkinson, D. MacDonald,
K. Lindgreen, K. Billard, B. Hawkins)

Indexing and on-line data entry into GEOSCAN continued throughout 1986 for Nova Scotia Department of Mines and Energy bibliographic records. GEOSCAN is a bibliographic database which provides access to publicly available geoscience literature concerning the Canadian landmass and offshore regions. The database presently contains over 97,000 records and is co-operatively produced from the indexing contributions of twelve federal, provincial and professional geoscience organizations located throughout Canada. The Geological Survey of Canada, through the National GEOSCAN Centre, co-ordinates these indexing activities and provides computer resources in support of this project.

In 1986, 1121 new Nova Scotia Department of Mines and Energy records were added to GEOSCAN. They consisted of 205 assessment reports, 710 open file maps, 135 open file reports, 67 publications and 4 theses, representing an 11.5 per cent growth in the size of the Nova Scotia component of the database. As of August 31, 1986, the database contained 8,684 Nova Scotia Department of Mines and Energy records consisting of 3,918 assessment reports, 1,641 publications, 1,058 journal literature references, 750 open file maps, 720 open file reports and 597 theses.

A new five-year bibliographic index, entitled *Report 86-2 Index to Assessment Reports 1981 to 1985 (with Keyword and Map Indexes)*, was released in October 1986. The corresponding index *Report 86-4 Index to Publications, Open File Reports, Open File Maps and Theses 1981 to 1985* is in preparation, and will be published in 1987.

Providing public access to GEOSCAN is an accepted goal of all the participating organizations involved in the support of GEOSCAN. In order for it to receive the widest possible public exposure and to best serve the end-user, GEOSCAN will be marketed through one or more of the established database vendors in Canada. At present, vendor responses to the marketing of GEOSCAN are being solicited and it is anticipated that GEOSCAN will be publicly accessible through one or more vendors early in 1987. In anticipation of GEOSCAN becoming publicly available on-line, the conversion and standardization of Nova Scotia Department of Mines and Energy records that began in 1984 has now been virtually completed. By the time the database is available for public on-line enquiry, all our records should be available to be searched.

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*Funded by the Nova Scotia Department of Mines and Energy, and the Nova Scotia Department of Mines and Energy under the Canada-Nova Scotia Mineral Development Agreement.

MINERAL OCCURRENCES DATABASES ACTIVITIES*

(G. DeMont)

Information from the Metallic and Industrial Mineral Occurrence Data (MOD) cards has been used to create the Metallic and Industrial Mineral Occurrences Databases. These databases reside on a Digital PDP 1173 computer, using GEOBASE, a geographic information system (GIS) software package at the Maritime Resource Management Service (MRMS) in Amherst, Nova Scotia. MRMS will provide copies of the databases on magnetic tape, the results of custom searches of the databases, and plots of mineral occurrences upon request, on a fee-for-service basis. Complete listings of the contents of both mineral databases were published as *Open File Reports 599, 600 and 601 Metallic Mineral Occurrences Maps and Data Compilations,* and *Open File Reports 606, 607 and 608 Industrial Mineral Occurrences Maps and Data Compilations,* covering central, eastern and western Nova Scotia respectively.

Since the publication of Open File Reports 599, 600, 601, 606, 607 and 608, the MOD card files and the Mineral Occurrences Databases have been updated from information gathered from all assessment reports, open file reports and publications available during the years 1981 to 1985, and from the results of Department field work carried out in these years. One hundred fifty-nine new metallic mineral occurrences and 21 new industrial mineral occurrences were added to the databases from this update. The Metallic Mineral Occurrences Database now contains information on 1,053 mineral occurrences, and the Industrial Mineral Occurrences Database now contains information on 1,073 industrial mineral occurrences.

An IBM-AT microcomputer was recently obtained by the Mineral Inventory group, and the updated version of the metallic mineral occurrences database has been installed, using dBASE III PLUS as the database management software. Copies of the metallic mineral occurrences database, or the results of custom searches of the database, can be made available on diskette, upon request. Installation of the industrial mineral occurrences database on the microcomputer will be undertaken soon.

DRILLHOLES DATABASE ACTIVITIES*

(G. DeMont, D. Jakobsen)

Information on drilling in mineral exploration assessment reports has been used to create the Drillholes Database. As with the Mineral Occurrences Databases, this database resides at MRMS, on a PDP 1173 computer using GEOBASE software. Copies of the database, custom search results and drillhole plots can also be obtained from MRMS on a fee-for-service basis. Complete listings of the contents of the Drillholes Database were published in June 1986 as *Open File Reports 86-019, 86-020 and 86-021 Drillhole Compilations from Open Assessment Reports,* covering central, eastern and western Nova Scotia respectively. The information in these reports covers all open assessment reports available up to the end of December 1985. Approximately 10,000 drillholes are represented in these open file reports.

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*Funded by the Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

Throughout the summer of 1986, a project has been underway to add to the database all the drillholes reported in the departmental publications *Drilling Logs of Government Core Drills,* which are available from 1901 to 1985. Approximately 6,000 drillholes have been coded, extending from 1985 back to 1957, of which 1,976 have been entered into the database as of August 31, 1986.

As with the Mineral Occurrences Databases, it is planned to install the Drillholes Database on the microcomputer and provide similar products on diskette, if requested.

GOLD BIBLIOGRAPHY ACTIVITIES

(J. Gillespie-Wood)

Compilation of information for the gold bibliography, to be entitled *Gold in Nova Scotia: a Bibliography of the Geology, and Exploration and Mining Histories from 1832 to 1986,* is well advanced and publication is expected in 1987. The bibliography, over 500 pages in length, will contain over 1,300 references documenting 265 gold districts and occurrences. The bibliography will be organized into three parts: Part I will be an alphabetic author index; Part II will be an index by gold district, with each gold district being subdivided into an author index, an assessment report index and a map and cross-section index; and Part III will contain the following cross reference lists - gold district/NTS map/county, NTS map/gold district/county and county/gold district/NTS map.

MINERAL RESOURCE PROMOTION

R. R. Potter

Nova Scotia has a well established mining industry. At present fourteen metals, minerals and commodities are produced including tin, gypsum, anhydrite, salt, barite, coal, cement, limestone, dolomite, peat, clay products, sand and gravel, aggregate, and dimension stone. In 1985, the total value of commodities produced reached a record high of $325 million. More than 6000 people are directly employed in the Province's mining and mineral based manufacturing industry and this should increase substantially in the future with the potential for new gold, coal, petroleum and gas production.

The Nova Scotia Department of Mines and Energy has by itself and jointly with Energy, Mines and Resources Canada encouraged development by carrying out a large number of programs to evaluate the Province's geology and mineral resource potential. Projects completed or underway include studies of individual metals, minerals or commodities such as gold, gypsum, anhydrite, diatomite, dimension stone, fillers, extenders and those minerals required for the offshore petroleum industry. Geological environments with high potential for economic development have also been examined, and metallurgical, technical and financial evaluations have been completed or are now in progress. This work is compatible with provincial government policies related to economic development, outlined in the White Paper *Building Competitiveness* which was published in 1984. Prepared by the Nova Scotia Department of Development and a group of individuals from the private sector, this White Paper contained recommendations indicating that government could best support private industry by building on human resource strengths and by improving the overall business environment. Trade development was considered as one area that could help local firms build economic competitiveness and improve employment and income opportunities within Nova Scotia.

A Trade Development Authority was established by government in 1985 "to co-ordinate provincial involvement with trade and to create a trade facilitating environment". Three objectives were established:

- to increase exports of Nova Scotia products, both outside and within Canada;
- to achieve replacement of some imports with Nova Scotia products; and
- to strengthen the Province's trade facilities and support services.

These objectives will be met by:

- finding new markets around the world for Nova Scotia's products;
- developing new products so that Nova Scotia's trade becomes more diversified;

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*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Develoment Agreement

- improving the infrastructure that permits trade activity to take place; and
- seeking investment for the expansion of existing, and the establishment of new, trade-related businesses.

In February 1986, a Trade Development Strategy was prepared. Industries with potential for the development of new products, markets and investment were identified and included seafoods, forest products, mineral products, service industries and cultural products. The importance of infrastructure and other services to promote investment was also considered.

It is the objective of this project to implement these established policies by identifying opportunities for investment in further exploration and development. Special attention will be given to new products and new markets for Nova Scotia's minerals. Technical data on mineral resources will be supplemented by information on transportation, port and loading facilities, markets, mining and environmental laws, taxes, royalties, incentive programs and other information of interest to potential investors.

A general paper *Nova Scotian Mineral Resources, Opportunities in New Investment, New Products and New Markets* was presented at the Nova Scotia Mining Society meeting in June 1986. This has been followed up by visits to producing mines, significant mineral deposits and mineral occurrences. A series of promotional reports will be prepared for publication in 1987.

MINERAL LAND USE POLICY DEVELOPMENT*

D. B. Hopper and C. A. Dobson

The Nova Scotia Department of Mines and Energy is addressing the need to foster better understanding of Nova Scotia's mineral and energy resources through projects created under the Canada - Nova Scotia Mineral Development Agreement.

The staff of the Mineral Land Use Policy Development Project is gathering mineral resource land use information to study mineral industry requirements relative to the needs of other resource sectors, and to present a perspective on how and where the mineral resource sector should fit into a provincial land use policy.

The major thrust of the project is to supply mineral resource information to the provincial and municipal planning community. This community consists of planners and surface resource managers who are responsible for designating future land use in Nova Scotia. The Mineral Land Use Policy Development Project will give land use planners clear and more accessible information on the Province's mineral and energy resources to benefit the decision-making process of future land use zoning.

The project's overall objective is to promote proper management and protection of mineral resources by providing information, interpretation and resource management guidance to the provincial and municipal planning system.

MINLU - A MINERAL LAND USE INFORMATION BASE

The project's first phase involves extensive information gathering for the creation of MINLU - a mineral land use database. MINLU will contain information on lands that preclude exploration and mining activity as well as those lands where industrial activity is limited in some way. Sets of Mineral Resource Land Use (MRLU) Handbooks with maps are also being compiled for MINLU. Currently, work is progressing on 14 NTS map sheets covering Halifax County. Information plotted on the MRLU maps has been collected from a number of sources within the Department. These sources include several inventories compiled by the Department as sand and gravel; mineral occurrences; peat and diatomite and building stone; land use files; the drillhole database; GEOSCAN; files on abandoned mine shafts (operation minecap); coal resource files; and other data found in publications, reports and maps. The products derived from MINLU will include 24 MRLU Handbooks with maps, each representing a rural municipality. These handbooks will be made available as departmental reports in hard copy and on computer data diskettes.

Another aspect to MINLU is the collection and organization of information from other surface resource sectors. As part of its resource management responsibilities, the Nova Scotia Department of Mines and Energy is monitoring land use policies being developed by other resource sectors such as forestry, fisheries, agriculture and recreation. In an environment of complex, multiple land use issues shared by several resource sectors, the Department's consultation with other resource managers is crucial.

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*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

The project is broad in scope and embodies many aspects of the Province's natural resource sectors. This year a land use planner was added to staff to assist with the project's growing workload and to increase the production rate of the MRLU Handbooks. Also an IBM-PC AT microcomputer was acquired to automate the database and will be used to produce data diskettes for municipal land use planners and resource managers.

METALLOTECTONIC MAP

J. D. Keppie

GENERAL BACKGROUND

Until the 1950s the relationship between mineral deposits and tectonic setting received very little attention because most deposits were considered to be related to intrusive magmatic processes, which were generally unrelated to the host rocks. Starting in 1948, Bilibin and other Russian geologists derived geotectonic groups of mineral deposit types related especially to intrusive rocks occurring at various geosynclinal stages (Bilibin, 1955; McCartney and Potter, 1962). This led to the production of metallogenic maps in many countries around the world.

With the advent of plate tectonics, there were attempts to relate mineralization to plate tectonics, e.g. porphyry Cu and Sn-W to subduction-related magmatic arcs, and stratiform massive sulphides to volcanic arcs (Kuroko-type) and mid-oceanic ridges (Cyprus-type). While the emphasis was initially upon the deposits in magmatic arcs and oceanic rise settings, other tectonic settings are receiving increasing attention (e.g. intra-continental rifts and collisional magmatism (Mitchell and Garson, 1981)). This should lead to a new generation of metallogenic maps depicting the origin of mineral deposits in terms of their plate tectonic setting. The term Metallotectonic Map, is proposed here to distinguish these maps from the earlier generation. First attempts in this direction have been made by Chatterjee (1983) for Nova Scotia and state geologists in New South Wales. However this has largely been accomplished by superimposing the metallogenic data on a plate tectonic map or a modification thereof. No comprehensive tectonic grouping of mineral deposits, as accomplished by Bilibin, has been produced. This will be attempted for the Metallotectonic Map of Nova Scotia, in which the term "Metallotect" is coined for the tectonic groups of mineral deposit. More specifically, a Metallotect is defined as a genetically related group of ore elements which is cogenetic with a tectonic element.

BASE MAP

The base for the Metallotectonic Map will be an updated version of the Tectonic Map of Nova Scotia (Keppie, 1981; 1982) modified to show new mapping and interpretations. The legend will be changed to include isotopic age data and plutonic rocks reclassified to show their tectonic setting. Also to be shown with an overprint pattern are rock units or tectonic elements anomalous with respect to specific metals or groups of metals. Potential mineralization domains derived from spatial geological, geophysical, geochemical and remote sensing parameters associated with metallotects will be outlined.

MINERAL OCCURRENCE SYMBOL

The main symbol (Fig. 1) will be coloured according to its metallotect:

(i) the outer part of the symbol will be coloured to show the percentage of different metals; a superimposed pattern will indicate whether the metal is a sulphide, silicate, native metal, oxide, sulphate, carbonate, halide, etc., and

(ii) the inner part of the symbol will be coloured according to the genetically related tectonic element with the appropriate abbreviation.

Surrounding symbols will show:

(a) genetic factors: the source of the fluids and metals, the age of the deposit and the metal source age,

(b) location controlling factors: host rock lithology, structure and metamorphism, and

(c) exploration indicators: geochemical and geophysical anomalies.

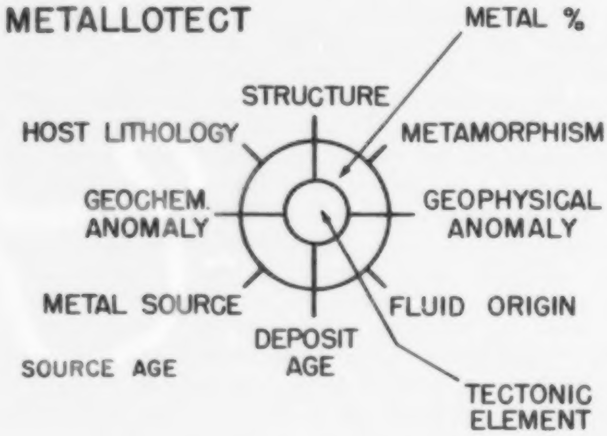
METALLOTECT
METAL %
STRUCTURE
HOST LITHOLOGY
METAMORPHISM
GEOCHEM. ANOMALY
GEOPHYSICAL ANOMALY
METAL SOURCE
FLUID ORIGIN
DEPOSIT AGE
SOURCE AGE
TECTONIC ELEMENT

Figure 1. Mineral occurrence symbol.

APPLICATION

The depiction of factors controlling the present location of known mineral deposits and occurrences together with geophysical and geochemical anomalies should provide a powerful exploration tool allowing extrapolation into areas possessing similar geological factors and anomalies but as yet undiscovered mineral occurrences. Knowledge of the genesis of individual deposits should allow the generation of predictive models for the location of environments where deposits have yet to be discovered. For example, several tectonic elements are present in Nova Scotia, but the associated metallotect is at present unknown. As well, tectonic elements or rock units which are anomalous with respect to certain metals have potential for undiscovered deposits.

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CUMBERLAND BASIN PROJECT - AN UPDATE*

R. C. Boehner, R. J. Ryan and D. C. Carter

INTRODUCTION

The Cumberland Basin is a large (3600 km^2) Carboniferous structural basin in northern Nova Scotia and southeastern New Brunswick (Fig. 1). The basin contains over 7000 m of dominantly continental clastic sedimentary rocks with one major succession of evaporitic-marine strata (Boehner et al., 1986a). The basin fill ranges in age from Devono-Carboniferous to Early Permian and was deposited north of the Cobequid Highlands Massif and south of the Caledonia Highlands Massif following the Acadian Orogeny.

STRUCTURE

The internal structure of the basin is a synclinorium with two *en echelon* diapiric anticlinal structures, the Claremont (Malagash) and the Minudie Anticlines (Figs. 1 and 2). The intervening Wallace Syncline contains several isolated evaporite diapiric structures. Major synclines include the Athol Syncline, the Tatamagouche (locally doubly plunging) Syncline and the Dorchester Syncline north of the Minudie Anticline. The east-west folding is complicated by subparallel longitudinal and transverse faults with similar orientations to the Glooscap Fault System (Minas Geofracture). The nature of these faults in the subsurface is unclear.

Onlap of younger strata at the basin margins limits exposure of pre-Namurian strata. The pre-Namurian strata are exposed in the axial areas of the diapiric anticlines and the domes. Seismic surveys and a few deep petroleum exploration wells have established the occurrence of 1000 to 2000 m of Horton and Windsor Group rocks at depth within the basin. Remnants of Late Devonian-Early Carboniferous felsic and mafic volcanics, fanglomerates, sandstones and siltstones of the Fountain Lake Group occur along the basin margin and beneath the Carboniferous onlap unconformity at the eastern and western end of the Cobequid Highland Massif.

The area has a long history of coal and salt mining as well as building stone production. Until the turn of the century, there was a small but active copper mining industry in the area. The Cumberland Basin contains numerous sediment-hosted metallic mineral occurrences of Cu-Pb-Zn-Ag-Au-U mineralization. Nonmetallic mineral resources include barite, celestite, salt, potash and limestone. Native sulphur has recently been recognized in the Pugwash mine (Carter, this volume) and new development work has been undertaken at the Beckwith celestite prospect and the Dewar Hill limestone property near Pugwash.

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*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

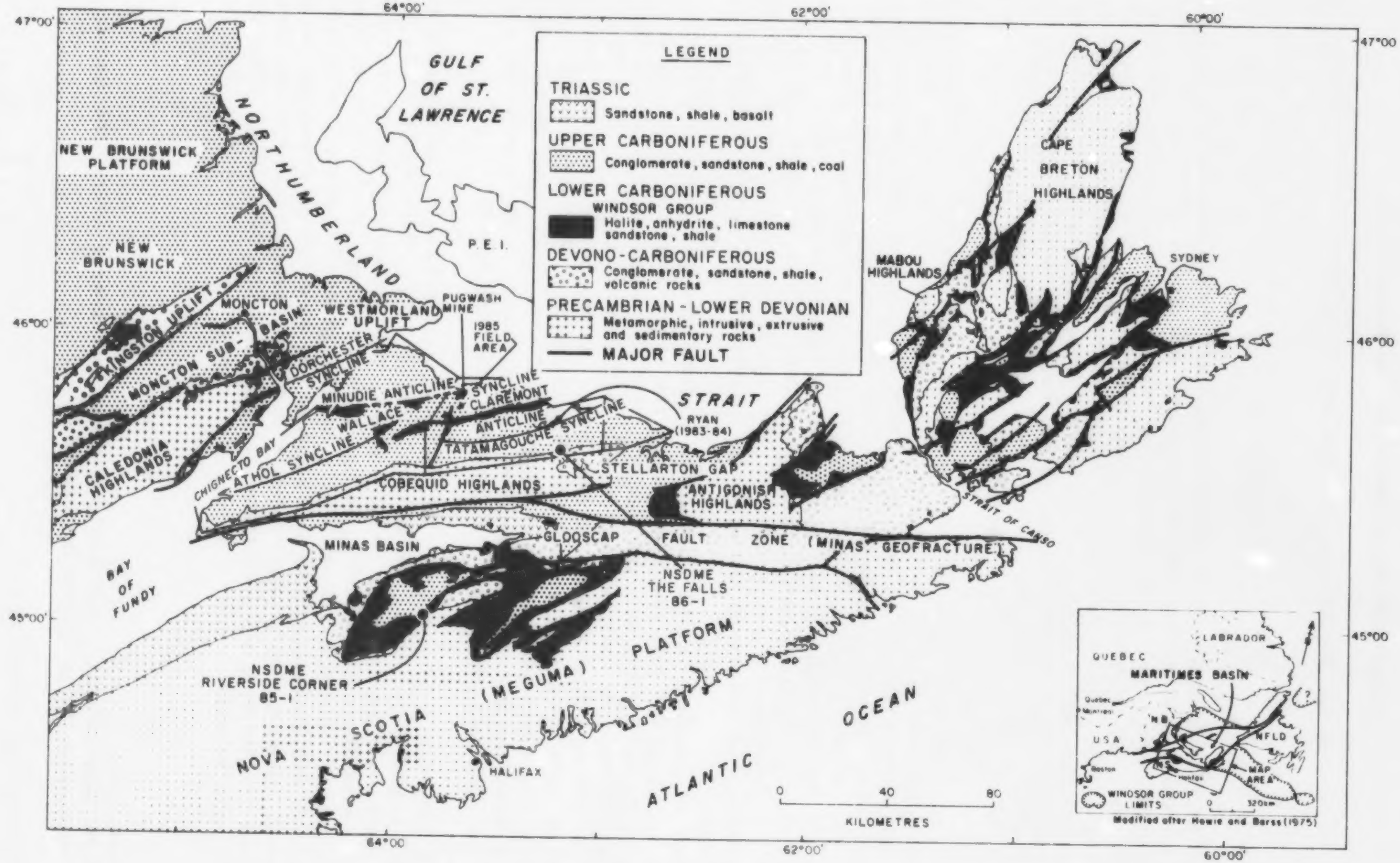

LEGEND
TRIASSIC
Sandstone, shale, basalt
UPPER CARBONIFEROUS
Conglomerate, sandstone, shale, coal
LOWER CARBONIFEROUS
WINDSOR GROUP
Halite, anhydrite, limestone sandstone, shale
DEVONO-CARBONIFEROUS
Conglomerate, sandstone, shale, volcanic rocks
PRECAMBRIAN - LOWER DEVONIAN
Metamorphic, intrusive, extrusive and sedimentary rocks
MAJOR FAULT
GULF OF ST. LAWRENCE
NORTHUMBERLAND
STRAIT
P.E.I.
NEW BRUNSWICK PLATFORM
NEW BRUNSWICK
KINGSTON UPLIFT
MONCTON SUB-BASIN
MONCTON
CALEDONIA HIGHLANDS
WESTMORLAND UPLIFT
DORCHESTER SYNCLINE
PUGWASH MINE
1985 FIELD AREA
MINUDIE ANTICLINE
CLAREMONT SYNCLINE
ANTICLINE
WALLACE
TATAMAGOUCHE SYNCLINE
ATHOL SYNCLINE
CHIGNECTO BAY
COBEQUID HIGHLANDS
RYAN (1983-84)
STELLARTON GAP
ANTIGONISH HIGHLANDS
GLOOSCAP FAULT ZONE (MINAS GEOFRACTURE)
MINAS BASIN
BAY OF FUNDY
NSDME THE FALLS 86-1
NSDME RIVERSIDE CORNER 85-1
(MEGUMA) PLATFORM
NOVA SCOTIA
HALIFAX
ATLANTIC OCEAN
CAPE BRETON HIGHLANDS
MABOU HIGHLANDS
SYDNEY
STRAIT OF CANSO
0
40
80
KILOMETRES
47°00'
46°00'
45°00'
64°00'
62°00'
60°00'
QUEBEC
LABRADOR
MARITIMES BASIN
Quebec
Montreal
N.B.
U.S.A.
Boston
N.S.
Halifax
NFLD
MAP AREA
WINDSOR GROUP LIMITS
0
320km
Modified after Howie and Barss (1975)

Figure 1. Regional geology and location map.

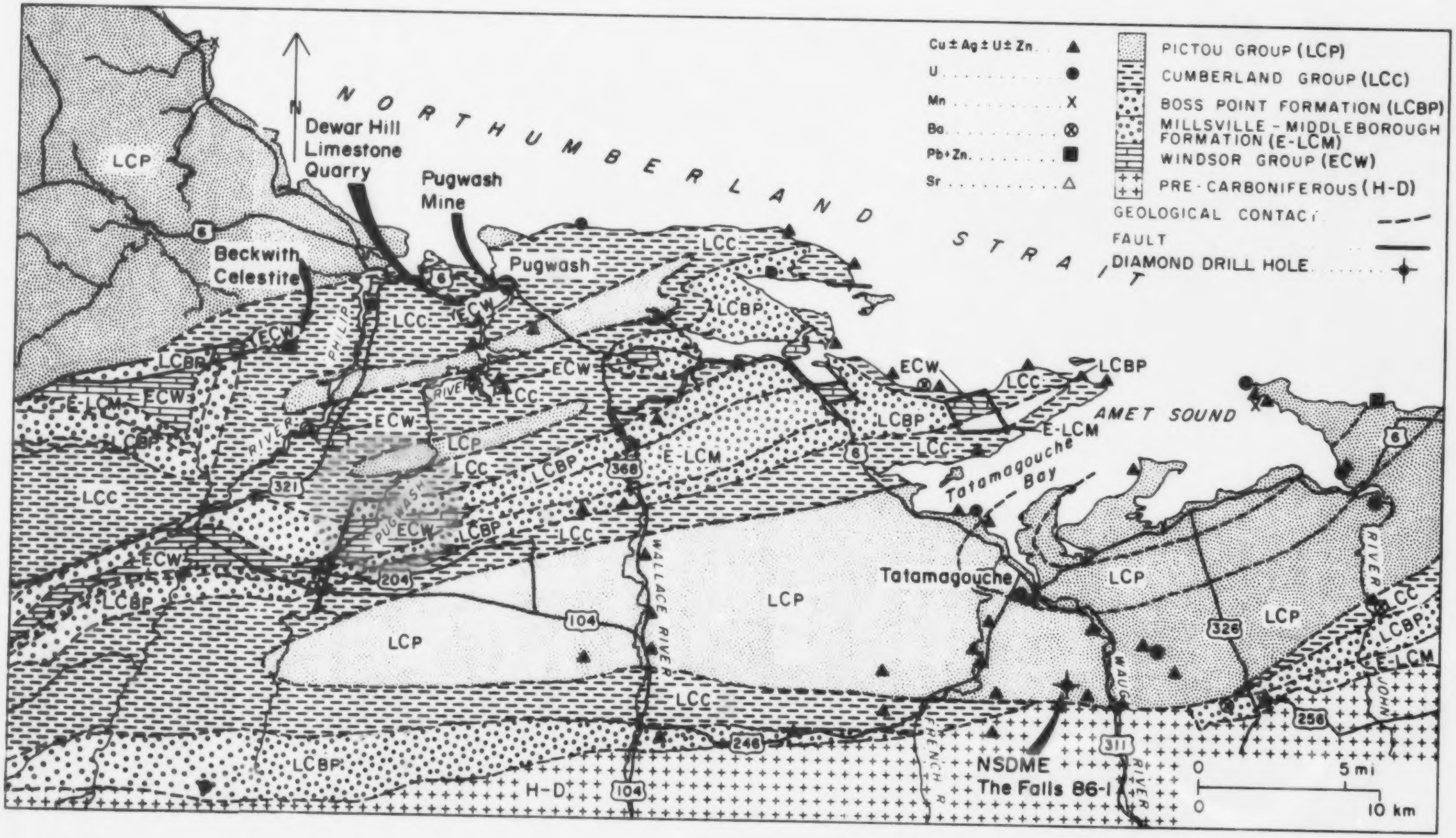

N
NORTHUMBERLAND STRAIT
Dewar Hill Limestone Quarry
Pugwash Mine
Beckwith Celestite
Pugwash
LCP
LCC
LCBP
ECW
E-LCM
H-D
PHILIP
RIVER
PUGWASH
WALLACE RIVER
AMET SOUND
Tatamagouche Bay
Tatamagouche
FRENCH R
WAUGH RIVER
JOHN RIVER
NSDME The Falls 86-1
6
321
204
368
104
246
311
326
256
Cu ± Ag ± U ± Zn ▲
U ●
Mn X
Ba ⊗
Pb+Zn ■
Sr △
PICTOU GROUP (LCP)
CUMBERLAND GROUP (LCC)
BOSS POINT FORMATION (LCBP)
MILLSVILLE - MIDDLEBOROUGH FORMATION (E-LCM)
WINDSOR GROUP (ECW)
PRE-CARBONIFEROUS (H-D)
GEOLOGICAL CONTACT
FAULT
DIAMOND DRILL HOLE
0
5 mi
0
10 km

Figure 2. Geology and mineral deposits of the eastern part of the Cumberland Basin, Nova Scotia.

ACTIVITIES

The varied activities of project staff during the past year include:

1. field mapping that continued west of the area previously described in Boehner, Ryan and Carter (1986); major units previously recognized are traced into the new area and mapping is essentially complete within NTS map sheet 11E which constitutes part of the Cumberland Basin (Boehner and Ryan);
2. detailed mapping in the Canadian Salt Company Limited Pugwash Mine (Carter);
3. stratigraphy and exploration potential of the Windsor Group (Boehner);
4. diamond-drilling for Carboniferous stratigraphy and mineral potential information near The Falls on the south border of the Tatamagouche Syncline (Ryan);
5. contributions to major international symposia including Sediment-Hosted Stratiform Copper Deposits held at the Geological Association of Canada annual meeting in Ottawa (see Ryan et al., in press(b)) (Ryan and Boehner) and the Basins of Eastern Canada and Worldwide Analogues Symposium held in Halifax (Ryan et al., in press(a); Boehner et al., 1986; Boehner, 1986) (Boehner, Carter and Ryan).

Preliminary results from this activity are outlined in subsequent sections.

SEDIMENTATION AND TECTONICS

Three allocycles have been recognized within the Middle Devonian and Early Permian strata of the Cumberland Basin (Ryan et al., ibid). These are the Mid-Devonian to Namurian, the Namurian to Westphalian A and the Westphalian D to the Early Permian. Each of these megasequences records a decelerating subsidence rate. An initial period of uplift of the highlands and rapid subsidence of the adjacent basin resulted in the deposition of coarse fanglomerates locally at the basin margins (Ryan et al., ibid). These coarse marginal deposits are succeeded by a transition to fluvial, lacustrine and, in the case of the Windsor Group, marine basin fill of widespread extent which may overstep the older basin fill units and the basement rocks.

The distribution of marginal alluvial fan deposits indicates that the Cobequid Highlands Massif was a fault-bounded wedge which tilted in different orientations through time in response to strike-slip movement along the faults.

Paleomagnetic surveys of the major stratigraphic units in the basin including the conglomeratic units are currently in progress by W. Morris in co-operation with the Geological Survey of Canada. These studies may assist in constraining the ages of the episodic fanglomerate deposition along the basin margins.

ECONOMIC GEOLOGY

Cu-Ag occurrences are abundant within the Pictou redbeds of the Cumberland Basin (Figs. 2 and 3). The Cu mineralization occurs as

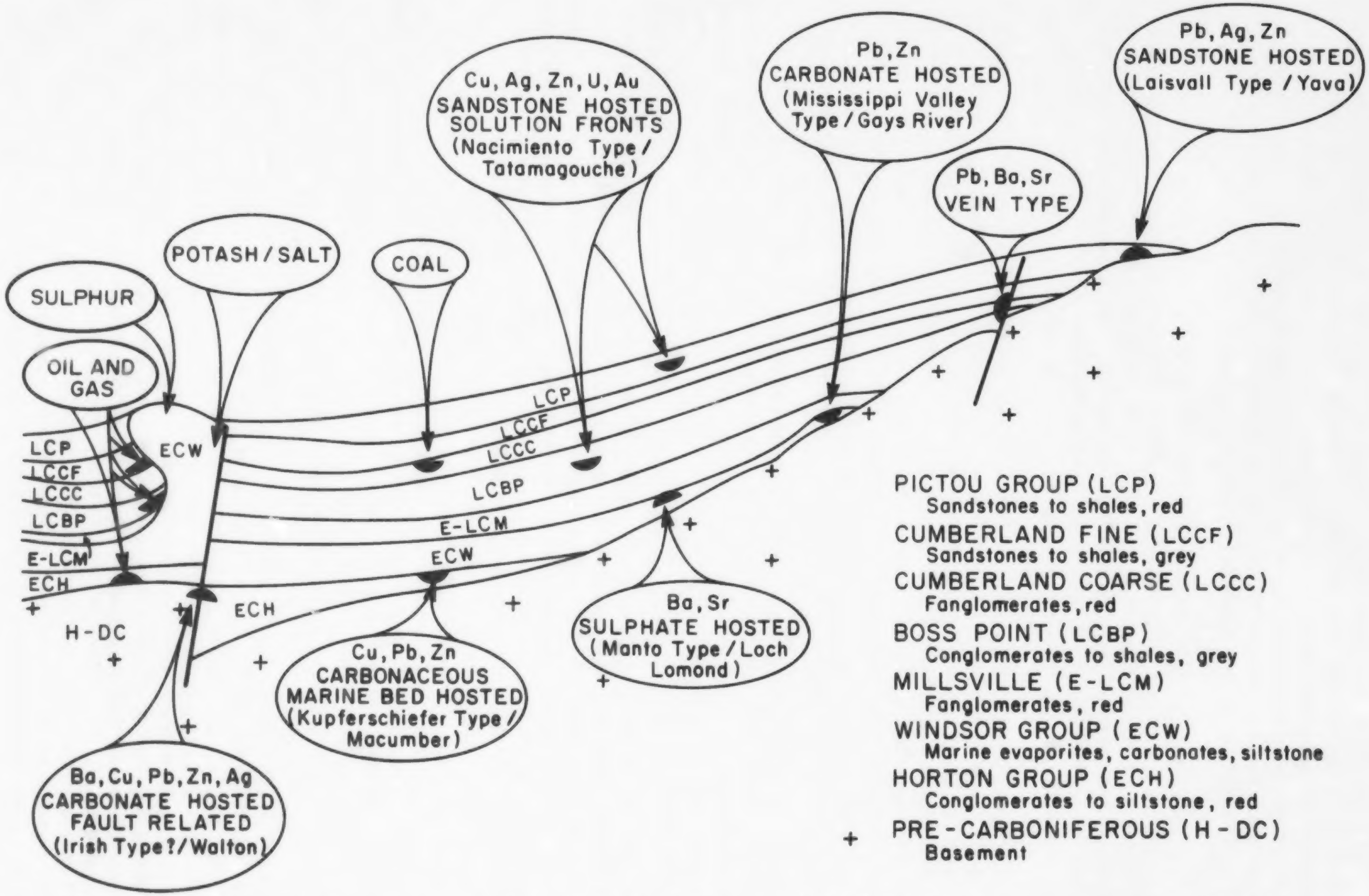

Pb, Ag, Zn
SANDSTONE HOSTED
(Laisvall Type / Yava)
Pb, Zn
CARBONATE HOSTED
(Mississippi Valley
Type / Gays River)
Cu, Ag, Zn, U, Au
SANDSTONE HOSTED
SOLUTION FRONTS
(Nacimiento Type /
Tatamagouche)
Pb, Ba, Sr
VEIN TYPE
POTASH / SALT
COAL
SULPHUR
OIL AND
GAS
LCP
LCCF
LCCC
LCBP
E-LCM
ECW
ECH
H - DC
Ba, Sr
SULPHATE HOSTED
(Manto Type / Loch
Lomond)
Cu, Pb, Zn
CARBONACEOUS
MARINE BED HOSTED
(Kupferschiefer Type /
Macumber)
Ba, Cu, Pb, Zn, Ag
CARBONATE HOSTED
FAULT RELATED
(Irish Type?/Walton)
PICTOU GROUP (LCP)
Sandstones to shales, red
CUMBERLAND FINE (LCCF)
Sandstones to shales, grey
CUMBERLAND COARSE (LCCC)
Fanglomerates, red
BOSS POINT (LCBP)
Conglomerates to shales, grey
MILLSVILLE (E-LCM)
Fanglomerates, red
WINDSOR GROUP (ECW)
Marine evaporites, carbonates, siltstone
HORTON GROUP (ECH)
Conglomerates to siltstone, red
+ PRE-CARBONIFEROUS (H - DC)
Basement

Figure 3. Diagrammatic representation of known and potential mineral and energy resource deposit setting.

chalcocite with pyrite and bornite near the red to grey boundaries within the strata. The depth (up to 440 m) of the mineralization suggest it is not shallow supergene (<20 m) as proposed by Brummer (1958). The Canfield Creek prospect (300,000 tons of 1.2% Cu) demonstrates the potential for deeper and larger deposits of Cu than those previously described and locally exploited in the area.

The redbeds of the Cumberland Basin have a secondary (diagenetic) origin (Ryan et al., in press(b)). The reddening process was coincident with incursion of oxygenated ground water deep into the basin during a period in which the water table was lowered. This major event probably occurred during the time interval represented by the Permian-Triassic unconformity.

Geochemistry of the tills (Stea et al., 1986) and stream sediments, as well as lithogeochemistry (Ryan et al., in press(b)) all suggest that there has been a depletion of Cu from the redbeds within the basin. It is therefore suggested that Cu-rich ground water flowed into the basin within permeable sandstone units until it encountered reductants, which were either fine- to coarse-grained coalfield plant material and pyrite within channel lags at the base of the channel sandstone bodies or the basinal saline waters or brines.

Ryan et al. (ibid) suggest that extensive areas of geochemically low Cu values (negative anomalies) associated with redbeds containing numerous Cu occurrences delineate potentially good areas to explore for this type of mineralization. The common association of Ag and Au with these occurrences enhances their attractiveness as exploration targets.

Investigation of the Windsor Group in the area is severely hindered by very limited outcrop and structural complexity that is further complicated by evaporite solution collapse. The stratigraphic succession is fragmentary and nowhere complete. Significant potential may exist for exploration and development of limestone-dolomite and gypsum deposits especially near Pugwash, Oxford and Hansford. A preliminary examination of the Lime Kiln Brook area, located approximately 40 km west of Pugwash, indicates similar limestone to that currently being developed at the Dewar Hill Quarry, near Pugwash. Salt and potash potential is considerable, although, structural complexity and stratigraphic uncertainty hinder exploration drilling activity.

STRATIGRAPHIC DRILLING

During the 1986 field season a drillhole, Nova Scotia Department of Mines and Energy TF-86-1, was completed to a depth of 785.5 m (2,577 ft) near The Falls, Colchester County. The hole was drilled to evaluate the nature of stratigraphic onlap of Upper Carboniferous strata onto the Devono-Carboniferous and older basement rocks along the southern limb of the Tatamagouche Syncline. In addition, the drilling was designed to test several economic mineral models applicable to the Carboniferous geology in the area.

DRILLHOLE STRATIGRAPHY

Interbedded red and grey sandstones and mudstones of the Pictou Group (Westphalian D - Stephanian) were intersected from onset to a depth of 373.4 m followed by red polymictic fanglomerates of the Falls Formation and(or) the Millsville Formation (Late Devonian and(or) Namurian) to 785.5 m.

MINERALIZATION

Abundant pyrite, occurring sporadically (up to 1%) over 1 m intervals, and traces of chalcocite mineralization are present within grey carbon-rich sandstones of the Pictou Group from 259 to 297 m.

DISCUSSION

The results indicate that the Riversdale and Cumberland Group strata are probably overstepped in the vicinity of the drillhole, and the Late Carboniferous Pictou Group strata lie directly upon the Late Devonian(?) Falls Formation. Although no significant economic mineralization was found, the trace amounts demonstrate the potential for mineralization within coeval beds in the Tatamagouche Syncline area to the north.

GEOLOGY OF THE PUGWASH MINE - AN UPDATE

INTRODUCTION

The only demonstrable marine incursion into the Late Devonian-Early Permian Maritimes Basin (Carter and Pickerill, 1985) occurred during Early Carboniferous (Viséan) time and resulted in deposition of the Windsor Group evaporite clastic and carbonate sequence. High-order evaporites (including salt and potash) were deposited in semi-isolated troughs or depressions throughout the basin (Anderle, 1980). Three potash deposits are currently being developed in southern New Brunswick (Roulston and Waugh, 1983). Salt is being mined from deposits at Nappan and Pugwash (Boehner, 1986b) and the Magdelan Islands (Brisebois, 1981). Salt and potash also occur in southwestern Newfoundland (Anderle, 1982; Knight, 1983).

The Canadian Salt Company Limited mine at Pugwash affords an opportunity to examine the typical internal structure, sedimentology and stratigraphy of a complex diapiric evaporite deposit developed within diapiric anticlines in the Cumberland Basin. In addition, the Pugwash diapir may be similar to other discrete diapirs developed in deeper portions of the Maritime Basin.

LOCAL GEOLOGY

Windsor Group strata define a northeast trending elongated ellipsoidal outcrop pattern at Pugwash in the Cumberland Basin (Fig. 1). Surface exposures consist of steeply dipping to overturned mudstone-sandstone with fossiliferous marine carbonate (B subzone, Bell, 1958) to the southwest of the Pugwash Mine. At this locality (Dewar Hill Quarry) Late Carboniferous rocks rest with angular unconformity on the steeply dipping Windsor Group. The remainder of the area is predominantly submerged beneath Pugwash

Harbour. However, karst topography, diamond-drilling and underground mine workings indicate that the rocks comprising the Windsor succession are predominantly deformed evaporites (salt and anhydrite). Although, the stratigraphic and structural relationship of the evaporites to the strata at Dewar Hill is not clearly defined, the evaporites are interpreted to be stratigraphically lower in the succession.

The geology of the Pugwash Salt Mine has been described by Evans (1965, 1967, 1972 and 1974) whose work documents the internal structure, mode of deposition and the stratigraphy of the deposit based on the workings available at that time (630 foot level). Additional work on the bromine geochemistry (Baar, 1966) and authigenic minerals (Aumento, 1964) was carried out from the same area. Work is currently in progress (Carter, 1985) on the sedimentology, stratigraphy and structure of the deposit incorporating data from the 830 and 730 foot levels and exploratory work for the 1000 foot level.

The evaporite sequence exposed in the Pugwash Mine consists of massive, nodular and stylolitic anhydrite and clear, white, reddish brown to black halite with minor occurrences of carnallite and sylvite. The anhydrite and halite occur as both thick beds and thinly interbedded intervals transitional to each other. The sequence has been extensively deformed and Evans (1972) concluded that the fold configuration and severity of deformation were similar to the structural configuration of diapirs, but suggested the Pugwash structure is intermediate between a true piercement diapir and a deformed anticline. The halite and, to a lesser extent, the anhydrite have deformed plastically and the halite shows extensive flowage characteristics including mylonite development. The anhydrite units have been ruptured and rafted passively by halite flowage with resulting attenuation and elimination of parts of the sequence. This boundinage development has left a complex series of steeply dipping anhydrite units interstratified with and isolated in a halite matrix (Fig. 4). Similar sequences have been noted by Richter-Bernberg (1980) as typical of emigration or thinning of the salt deposit and here are combined with a predominant structure of curtain folds having more or less vertical axes. Current work indicates that the Pugwash salt deposit represents a true piercement diapir and that the present deposit may in fact be a remnant of the original.

Although the evaporite sequence is structurally complex, individual anhydrites and ultimately the intervening halite units can be identified and correlated. Goodman (1985) suggested ten anhydrite units, however Evans (1972) and Carter (1985) identified two lithologically distinct anhydrites which can be correlated throughout the deposit. Most recent work indicates that there are in fact three anhydrite units (Fig. 4).

The stratigraphic sequence exposed in the Pugwash Mine is shown in Figure 5. The bottom of the evaporite sequence is assumed to be the salt underlying the shaft anhydrite member. The upper most part of the evaporite sequence exposed by mining, have identified as a third discrete anhydrite unit, is stratigraphically and structurally conformable with the clastics. It is noteworthy that this anhydrite is sulphur-bearing and the overlying clastics are oil-stained. Only estimates of the true thickness of the total sequence are possible due to extensive deformation and flowage of the halite. Work on the stratigraphy of the deposit is continuing.

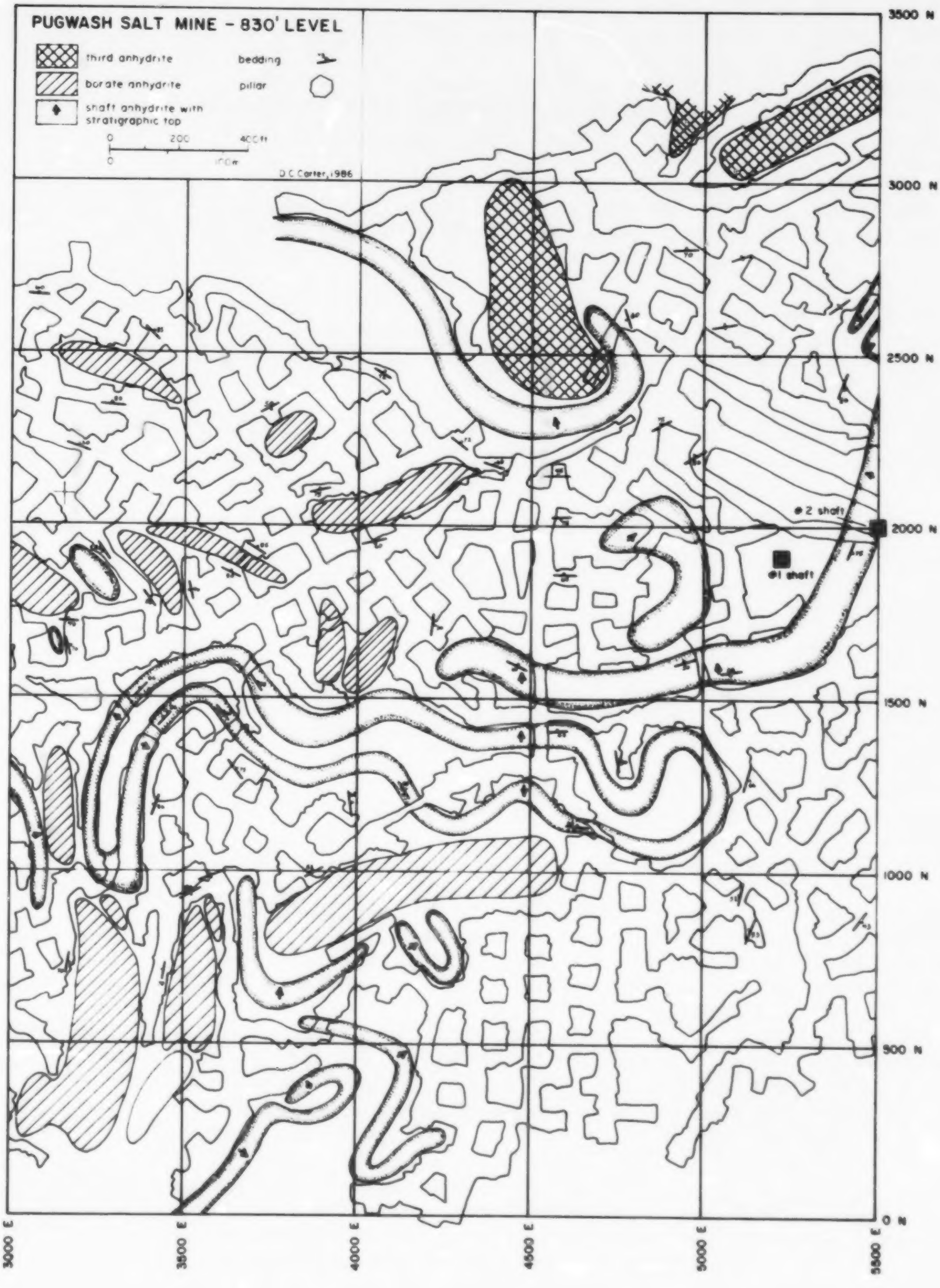
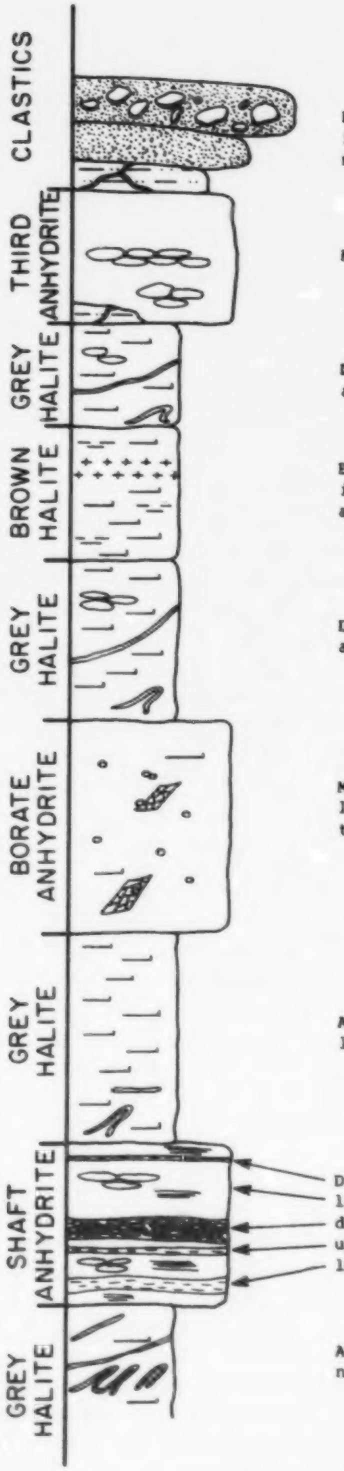

PUGWASH SALT MINE - 830' LEVEL
third anhydrite
borate anhydrite
shaft anhydrite with stratigraphic top
bedding
pillar
0 200 400 ft
0 100 m
D.C. Carter, 1986
#2 shaft
#1 shaft
3500 N
3000 N
2500 N
2000 N
1500 N
1000 N
500 N
0 N
3000 E
3500 E
4000 E
4500 E
5000 E
5500 E

Figure 4. Plan map of a portion of the 830 level of the Pugwash Salt Mine showing distribution and lithology of the anhydrite members which have been boundinaged and passively rafted during the development of the diapir.


CLASTICS
THIRD ANHYDRITE
GREY HALITE
BROWN HALITE
GREY HALITE
BORATE ANHYDRITE
GREY HALITE
SHAFT ANHYDRITE
GREY HALITE

Dark greenish grey to black, oil stained; siltstones fractured by anhydrite filled veins; anhydrite fragments in basal conglomerate

Massive to nodular and stylolitic with minor sulphur

Dominantly anhydrite insolubles; planar and contorted anhydrite laminae and nodules

Brown, orange, grey to black tinted by clay insolubles and minor primary copper-red carnallite and white, yellow and orange sylvite

Dominantly anhydrite insolubles; planar and contorted anhydrite laminae and nodules

Minor small crystals of primary halite and medium to large vugs filled with secondary halite; minor minute to small found danburite nodules

Anhydrite insolubles; contorted anhydrite nodules and laminae, more abundant toward base.

Dolomitic, oil-bearing siltstone;
laminated to nodular anhydrite;
dolomitic siltstone with small anhydrite nodules;
upper greenish grey clay;
lower grey and pale orange clay

Abundant, highly contorted anhydrite laminae and nodules.

Figure 5. Reconstructed stratigraphy of the Pugwash Salt deposit. No vertical scale implied.

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EVAPORITE BASIN STRATIGRAPHIC TEST DRILLING*

NSDME RIVERSIDE CORNER 85-1

D. C. Carter

The Riverside Corner 85-1 drillhole (NSDME RC 85-1) (Fig. 1) was located to examine the stratigraphy, structure and potash potential of the Clarksville salt occurrence in the Kennetcook River gravity low (Boehner, 1986). The Clarksville occurrence is located 1.5 km north of Clarksville, Hants County, 26 km northeast of Windsor. The Kennetcook River gravity low is one of the largest (30 km by 6 km), virtually unexplored gravity anomalies in Nova Scotia (Boehner, ibid). This 30 mgal Bouguer gravity low (Fig. 1) parallels the regional strike and extends from Stanley in the southwest to Kennetcook in the northeast. Potential for salt and potash is indicated by limited previous drilling, salt springs and scattered high bromine analyses. The reader is referred to the compilation by Boehner (ibid) and mineral assessment reports by Cominco Limited (1981) for a detailed discussion of the exploration history and geophysics of the area.

Drilling of Riverside Corner 85-1 was conducted in late 1985 and early 1986 by the Nova Scotia Department of Mines and Energy to assess the potash potential of selected areas of the Province as part of the Canada - Nova Scotia Mineral Development Agreement. Nova Scotia Department of Mines and Energy Open File Report 86-040, which comprises a summary report on the drilling and a complete well history, should be useful as a reference for future work in the Clarksville area and for similar holes to be drilled elsewhere in the Province.

NSDME RC 85-1 was drilled to a total depth of 1057.6 m and cored from 78 to 1057.6 m. The following section was intersected:

0-52 m	overburden
52-132 m	Watering Brook Formation
132-434 m	Scotch Village Formation
434-495 m	Windsor Group (C subzone)
495-1057.6 m	Windsor Group (B subzone)

'Top of Salt' was intersected at 657 m within the B subzone (major cycle 2). This salt dominated section is complicated by at least six fold repetitions.

The Windsor Group main halite (A subzone, major cycle 1), with its possible potash target, was not intersected. This is due in part to the unusually thick section of Scotch Village Formation, depth to the 'top of salt' and structural complications (fold repetition and faulting). The maximum capabilities of the drill rig were not reached due to engineering problems. The potash potential of the Kennetcook River gravity low remains

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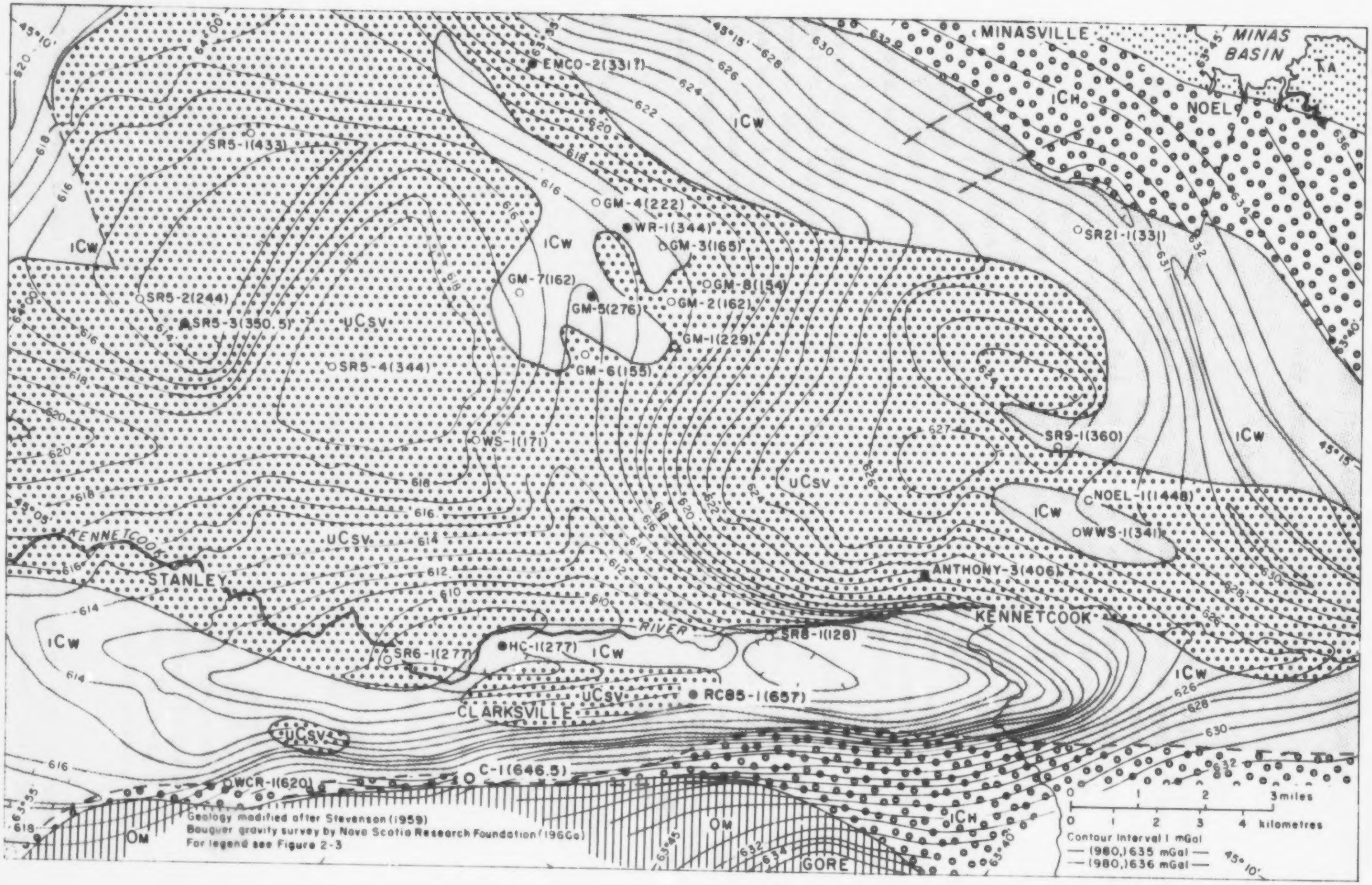
*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement


MINAS BASIN
TA
MINASVILLE
NOEL
lCH
lCw
uCsv
Om
KENNETCOOK
KENNETCOOK RIVER
STANLEY
CLARKSVILLE
GORE
EMCO-2(331?)
SR5-1(433)
SR5-2(244)
SR5-3(350.5)
SR5-4(344)
GM-4(222)
WR-1(344)
GM-3(165)
GM-7(162)
GM-5(276)
GM-8(134)
GM-2(162)
GM-1(229)
GM-6(155)
WS-1(171)
SR21-1(331)
SR9-1(360)
NOEL-1(1448)
WWS-1(341)
ANTHONY-3(406)
SR8-1(128)
HC-1(277)
SR6-1(277)
RC85-1(657)
C-1(646.5)
WCR-1(620)
45°15'
45°10'
45°05'
64°00'
63°55'
63°45'
63°40'
Contour interval 1 mGal
(980,)635 mGal
(980,)636 mGal
3 miles
4 kilometres

Geology modified after Stevenson (1959)
Bouguer gravity survey by Nova Scotia Research Foundation (1966a)
For legend see Figure 2-3

LEGEND

TRIASSIC

TRA *ANNAPOLIS FORMATION:* shale and sandstone

CARBONIFEROUS
UPPER CARBONIFEROUS

uCSV *SCOTCH VILLAGE FORMATION:* sandstone and shale

LOWER CARBONIFEROUS
WINDSOR GROUP

lCW Undivided siltstone, shale, anhydrite, gypsum, halite, and limestone

lCW-MP *MACUMBER AND PEMBROKE FORMATIONS:* limestone and limestone pebble conglomerate

HORTON GROUP

lCH Undivided sandstone, shale and conglomerate

ORDOVICIAN
MEGUMA GROUP

OM Undivided slate and metasandstone

SYMBOLS

Geological boundary (defined, approximate, assumed) .... ——— - - -
Fault (approximate) .... - - - - - -
Drillhole intersecting salt; number (depth to salt, metres) .... ● IP-1(520)
Drillhole without salt; number (Total depth, metres) .... ○ SR6 1(277)

Figure 1. Geological map and location of drillhole NSDME Riverside Corner 85-1 (RC 85-1) in the Kennetcook area, Hants County.

significant based on a confirmed intersection of halite-bearing B subzone Windsor Group strata. Information from this hole will be applied to a re-interpretation of geophysical data from the Clarksville area.

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SOUTH MOUNTAIN BATHOLITH PROJECT - BEDROCK MAPPING*

M. MacDonald, M. Corey, L. Ham and R. Horne

INTRODUCTION

The SMB is a large (>10 000 km^2) composite, peraluminous granitoid body which hosts the East Kemptville tin mine, near Yarmouth, and numerous polymetallic mineral occurrences (O'Reilly et al., 1982; Chatterjee, 1983).

As part of the ongoing geological mapping of the South Mountain Batholith (SMB), NTS map sheets 21A/09, 21A/10, 21A/15 and the west half of 21A/16 were completed during the 1986 field season. In combination with the 1985 field season mapping (Fig. 1) coverage constitutes more than half of the SMB. The principal goal of this project is to assess the mineral potential of the SMB, by initial regional scale mapping followed by petrographic and geochemical studies of the individual map units. The results of this work will lead to an increased understanding of the petrogenesis of the batholith which in turn will be invaluable to the determination of the mineral potential of the SMB.

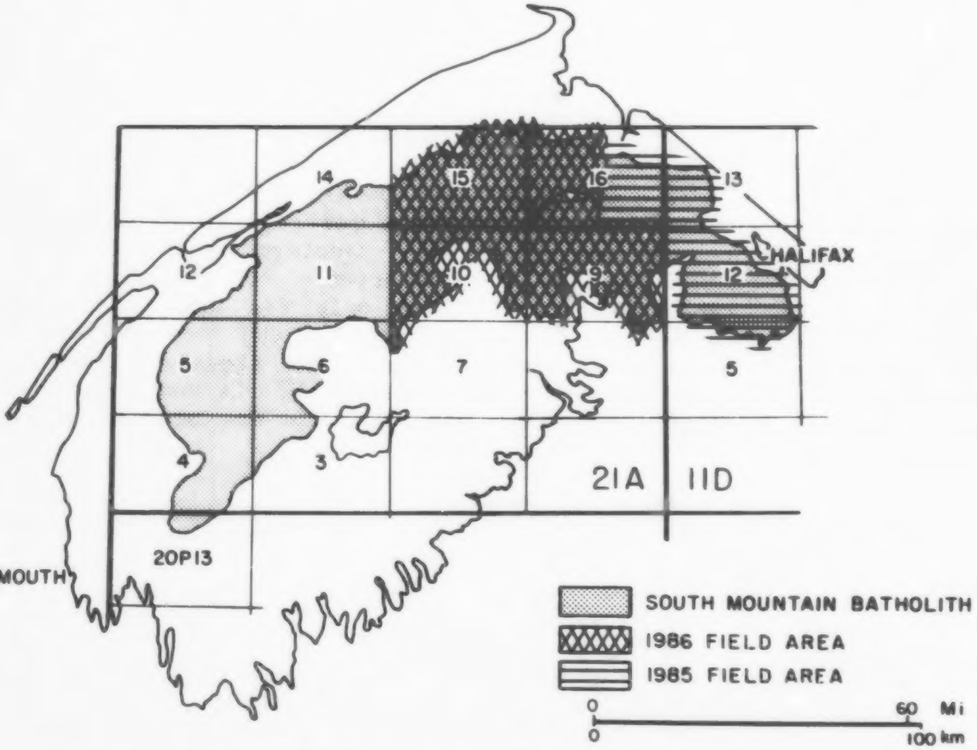
14
15
16
13
12
11
10
9
12
HALIFAX
5
6
7
5
4
3
21A
11D
20P13
YARMOUTH
SOUTH MOUNTAIN BATHOLITH
1986 FIELD AREA
1985 FIELD AREA
0
60 Mi
0
100 km

Figure 1. Location map.

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*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

GENERAL GEOLOGY

The granitoid rocks of the SMB have been divided into distinct mappable phases on the basis of their texture (e.g. equigranular, porphyritic, hypidiomorphic-granular, seriate), grain size (fine= <.1 cm, medium= 0.1-.5 cm, coarse= >.5cm) and modal contents of biotite, muscovite, cordierite and feldspar megacrysts (from visual modal estimates). Modal percentages of quartz, alkali feldspar and plagioclase from point counting of stained slabs have been used to determine the rock type of each unit according to the Streckeisen (1976) classification scheme.

Two major contributions to the understanding of the geology of the SMB made during the 1986 field season include:

1. The subdivision of monzogranitic rocks into distinct textural and compositional units, as well as better control over the geographic distribution of these rocks.

2. The subdivision of rocks previously classified as one granodiorite unit on the geology map by Keppie (1979) into distinct biotite granodiorite, monzogranite/granodiorite and biotite monzogranite units. A plot of modal quartz-alkali feldspar-plagioclase from 27 samples from these rocks is presented in Figure 2. The compositional range clearly extends across both the monzogranite and granodiorite fields of the Streckeisen diagram.

MINERAL OCCURRENCES

Twenty new mineral occurrences have been discovered during the 1986 field season. Table 1 is a summary of the pertinent information for each of the new mineral occurrences and Figure 3 displays the locations of these new showings. Numbers beside each occurrence correspond to the descriptions in the table and are intended only for use in this report. Several new fluorite occurrences were located along the New Ross-Vaughan road and are not numbered in the table and the figure. Known mineral occurrences which were compiled from published reports and assessment data have also been plotted on Figure 3 to display the overall pattern of mineralization.

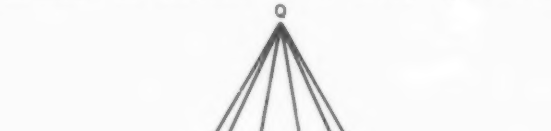

Figure 2. Quartz-alkali feldspar-plagioclase diagram (after Streckeisen, 1976).

Table 1. Summary of new mineral occurrences for NTS map sheets 21A/09, 21A/10, 21A/15 and 21A/16 (West).

#	Occurrence Name	NTS Sheet	Northing/Easting	Mineralization*	Mineralization Style(s)	Host Rock	Alteration	Remarks
1	Leville Road	21A/09	4955840/388470	cc, cr, wf	dissemination; pegmatitic	leucocratic porphyry	sercite	coarse disseminations (1 cm^2) of chalcocite altering to chrysocolla in both leucoporphyry and pegmatite pods; very minor wolframite also observed in pegmatite pods
2	Fox Point	21A/09	4939100/416370	py, cp, as	sheeted greisen-bordered quartz veins	medium- to coarse- grained 2-mica monzogranite	quartz-muscovite greisen	<1-2 cm wide quartz-muscovite greisen veins containing finely disseminated sulphides
3	Otter Lake	21A/10	4931950/374900	py, cp, wf	quartz veins	biotite monzogranite	-	sphalerite-, arsenopyrite-bearing quartz muscovite greisens and albitite dykes in the area documented by Corey (1982)
4	Whale Lake	21A/10	4933640/380380	wf, cp, mo, as, bo, py	quartz veins	biotite monzogranite	quartz-muscovite sulphide rich-greisen	1 cm wide quartz vein with <2 cm greisen
5	Saturday Lake	21A/10	4948675/362900	mo	sheeted quartz veins	mafic porphyry	-	angular boulders; located at contact between Meguma Group rocks and biotite granite
6	Falkland Ridge	21A/10	4945500/353760	mo, fl, sp, py	greisen-bordered quartz veins	biotite "granite" (i.e. compositions from monzogranite to granodiorite)	quartz, muscovite, sulphide greisen	located at the contact between Meguma Group rocks and biotite granite
7	Dog Falls	21A/10	4942860/356500	as, cp, py	quartz vein	biotite "granite"	quartz-muscovite greisen	quartz vein (<7 cm wide) (150/83W)
8	Tommy Lake	21A/10	4938800/342760	cp, mo, as, py	greisen-bordered quartz veins	leucocratic monzogranite	quartz-muscovite greisen	similar to Alton Road Copper mine and East Dalhousie tin showing (MacGillivray, 1982)
9	Scragg Lake "A"	21A/15	4957430/344630	py, as, cp, to	greisen-bordered quartz veins	biotite monzogranite	muscovite greisen	15 small (<1 cm wide) veins over 7 m with up to 2 cm of greisen development
10	Scragg Lake "B"	21A/15	4961800/342940	py, as, to	quartz vein	fine- to medium-grained 2-mica monzogranite	muscovite greisen (<0.5 cm)	3 small quartz veins (<1 cm wide) (164/69W)
11	Scragg Lake "C"	21A/15	4961730/343700	py, as, cp, bo	disseminated through greisen	leucocratic porphyry	muscovite greisen	angular boulders
				py, as, cp, to	greisen-bordered quartz veins	biotite monzogranite	muscovite greisen	angular boulders; miarolitic cavities (<3 cm diameter) occur in greisen
12	Scragg Lake "D"	21A/15	4960640/341950	as, py, cp, bo	greisen-bordered quartz veins	2-mica monzogranite	muscovite greisen	10 small (<2 cm wide) veinlets over several metres
13	Spry Lake	21A/15	4959730/349840	as, py	quartz vein	biotite monzogranite	-	1 small quartz vein (1-2 cm width)
14	Kerr Lake	21A/15	4968760/370150	au, tb, cp, ma, az, bo, py	quartz vein with associated pods of greisen; disseminated within host rock; fractures	fine grained 2-mica monzogranite dyke	muscovite greisen	vein type uranium mineralization; no shearing
15	Conrad Road	21A/16	4963875/398950	mo, fl	fracture-fillings	fine- to medium-grained 2-mica monzogranite dyke	-	greisen pods and pegmatitic segregations common within outcrop
16	South Canoe Lake #1	21A/16	4960470/395090	mo, fl	pegmatitic	leucogranite porphyry	-	molybdenite as fine disseminations (<3 mm); fluorite along 125°-140° trending fractures
17	South Canoe Lake #2	21A/16	4960640/393350	mo	disseminations	aplite dyke	muscovite greisen; kaolinite	45 cm wide dyke; abundant quartz and greisen veins within outcrop
18	Round Lake	21A/16	4957040/389130	wf	disseminations	fine grained leucogranite	sericite greisen	small blades of wolframite (<2 mm)
19	Falls Lake River	21A/16	4969130/402560	au(?)	fractures	fine grained 2-mica monzogranite dykes	-	dykes hosted by a gneissic roof pendant; elevated radiometric response in fractures
20	Harriston	21A/16	4956200/383940	au, tb	fractures	fine- to medium- grained 2-mica monzogranite	hematite	-
-	New Ross-Vaughan Road	21A/16	several locations along New Ross-Vaughan road	fl	fractures; disseminations	fine- to medium- grained 2-mica monzogranite	hematite, muscovite greisen	numerous fluorite occurrences at Leminster and Canoe Lake (O'Reilly et al., 1982)

*abbreviations:
au=autunite; as=arsenopyrite; az=azurite; bo=bornite; cc=chalcocite; cp=chalopyrite; cr=chrysocolla; fl=fluorite;
ma=malchite; mo=molybdenite;py=pyrite; sp=sphalerite; tb=torbernite; to=tourmaline; wf=wolframite

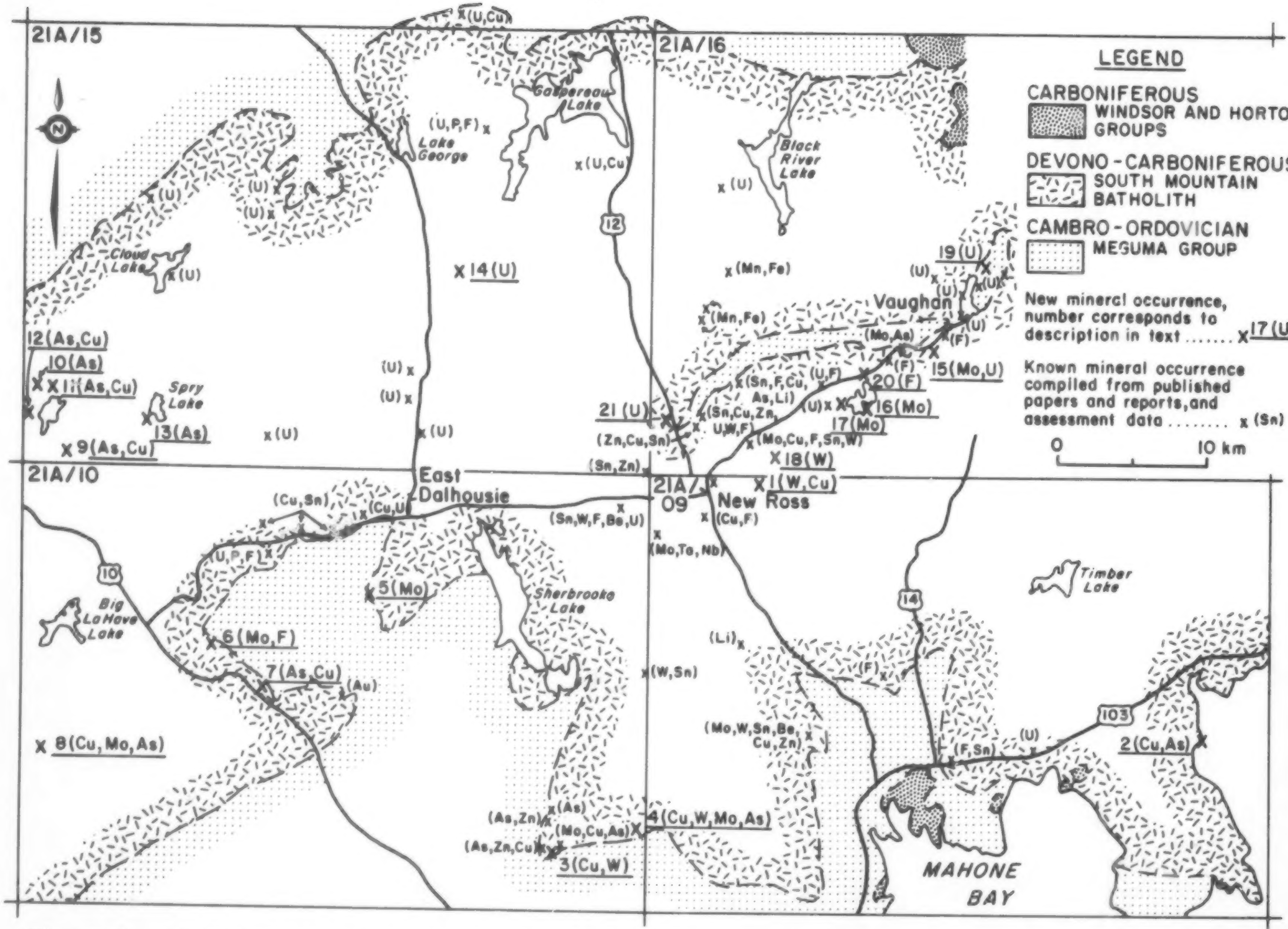
21A/15
21A/16
21A/10
21A/09
LEGEND
CARBONIFEROUS
WINDSOR AND HORTON GROUPS
DEVONO-CARBONIFEROUS
SOUTH MOUNTAIN BATHOLITH
CAMBRO-ORDOVICIAN
MEGUMA GROUP
New mineral occurrence, number corresponds to description in text .... X 17(U)
Known mineral occurrence compiled from published papers and reports, and assessment data .... x (Sn)
0
10 km
N
Cloud Lake
Spry Lake
Lake George
Gaspereau Lake
Black River Lake
Big LaHave Lake
Sherbrooke Lake
Timber Lake
MAHONE BAY
East Dalhousie
New Ross
Vaughan
10
12
14
103
1(W,Cu)
2(Cu,As)
3(Cu,W)
4(Cu,W,Mo,As)
5(Mo)
6(Mo,F)
7(As,Cu)
8(Cu,Mo,As)
9(As,Cu)
10(As)
11(As,Cu)
12(As,Cu)
13(As)
14(U)
15(Mo,U)
16(Mo)
17(Mo)
18(W)
19(U)
20(F)
21(U)
(U,Cu)
(U,P,F)
(U,Cu)
(U)
(Mn,Fe)
(Sn,F,Cu, As,Li)
(U,F)
(Sn,Cu,Zn, U,W,F)
(Mo,Cu,F,Sn,W)
(Mo,As)
(F)
(Zn,Cu,Sn)
(Sn,Zn)
(Sn,W,F,Be,U)
(Cu,F)
(Mo,Ta,Nb)
(Cu,Sn)
(Cu,U)
(Au)
(Li)
(W,Sn)
(F)
(Mo,W,Sn,Be, Cu,Zn)
(F,Sn)
(As,Zn)
(As)
(Mo,Cu,As)
(As,Zn,Cu)

Figure 3. Geological map of the study area indicating location of new and known mineral occurrences.

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PERALUMINOUS GRANITES OF THE LISCOMB COMPLEX*

P. S. Giles and A. K. Chatterjee

The Liscomb Pluton, as defined by Faribault (1901, 1902), is an irregular bi-lobate grantic body covering an area of approximately 350 km^2 and is the second largest pluton in the Eastern Meguma Zone. Geological mapping of the western half of the Liscomb Pluton has revealed that it is in fact composite in nature (Fig. 1) consisting of (i) a plutonic complex covering an area of 75 sq km^2, (ii) high-grade metamorphic rocks represented by felsic and mafic gneisses, and (iii) two diatremes/breccia pipes characterized by a volatile-rich matrix ranging in composition from quartz-gabbro to quartz-diorite containing a large assortment of xenoliths. Thus, it is more appropriate to consider the Liscomb Pluton as the Liscomb Complex.

Geological observations and field relationships (i.e. intrusive contacts, abundance and types of xenoliths, structural trends, variations in rock types at outcrop scale and the lack of penetrative fabric) suggest that the entire complex is intrusive into the deformed and metamorphosed Cambro-Ordovician Meguma Group rocks. Thus, the complex is post-tectonic and the inferred diapiric mechanism of intrusion implies a rapid uplift and emplacement of the complex in a time frame which is bracketed by Acadian metamorphism (415-400 Ma) and granitoid intrusion (370 Ma) in the Meguma Zone (Reynolds and Muecke, 1978; Clarke and Halliday, 1980).

Regional airborne radiometric surveys clearly indicate a contrast in the respective radiometric response of the western and eastern lobes of the Liscomb Complex. To assess this contrast, the granitoid rocks of the eastern lobe occurring in a section which approximates the variation from margin to the centre of the pluton were examined. For lack of better designation the authors have termed these rocks the Eastern Lobe monzogranite suite. The eastern lobe of the Liscomb Complex is presently the subject of a much broader investigation by K. Ford of the Geological Survey of Canada.

Granitic rocks of the western portion of the Liscomb Complex occur in seven discrete plutons (Fig. 1):

1. Twin Lake granodiorite
2. East Loon Lake biotite monzogranite
3. Sanctuary biotite monzogranite
4. Nelson Lake muscovite biotite monzogranite
5. Porcupine Lake muscovite-biotite monzogranite
6. South Loon Lake muscovite-biotite monzogranite
7. Moose Lake muscovite-biotite monzogranite

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*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

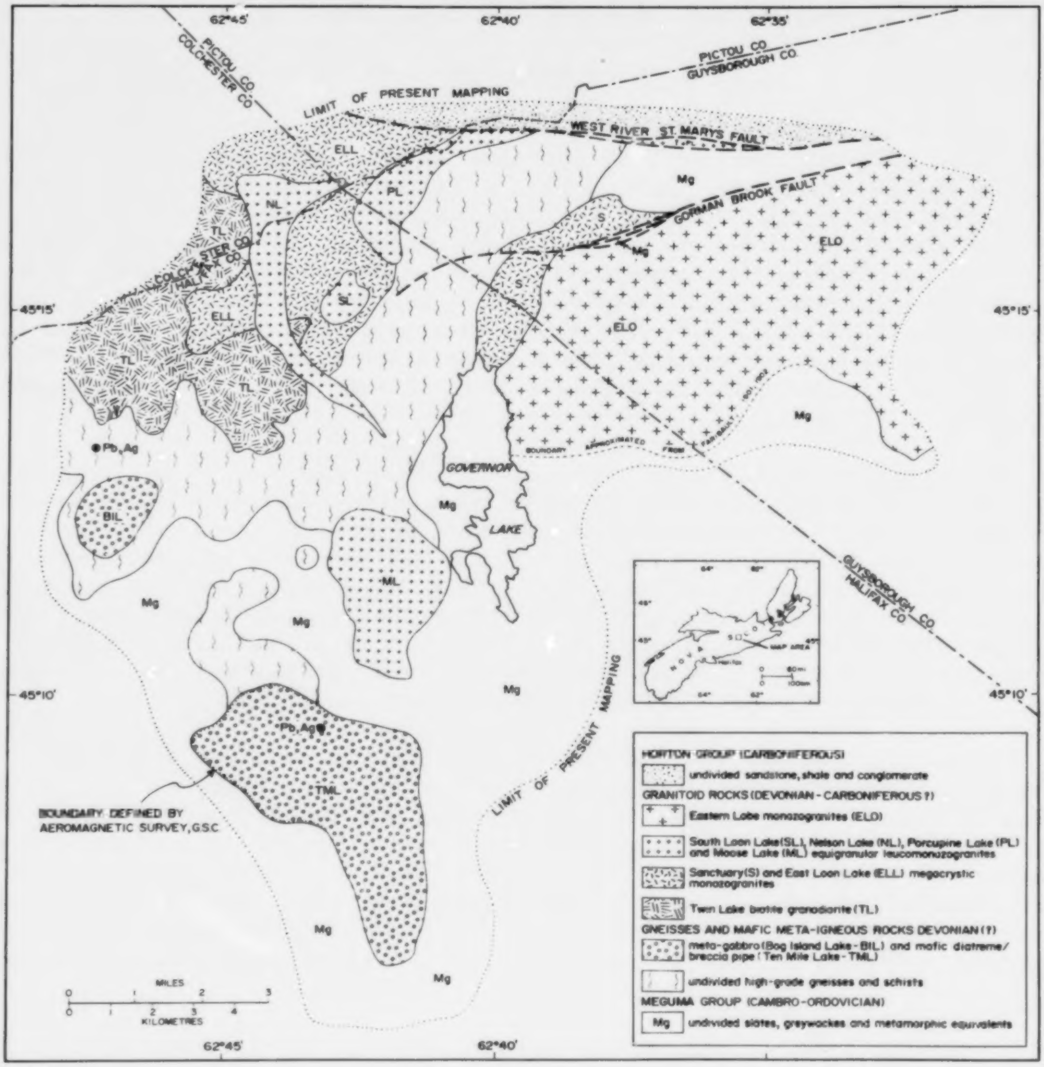
62°45'
62°40'
62°35'
PICTOU CO
COLCHESTER CO
PICTOU CO
GUYSBOROUGH CO
LIMIT OF PRESENT MAPPING
WEST RIVER ST. MARYS FAULT
GORMAN BROOK FAULT
COLCHESTER CO
HALIFAX CO
ELL
NL
PL
TL
SL
S
Mg
ELO
45°15'
GOVERNOR
LAKE
BOUNDARY APPROXIMATED FROM FARIBAULT, 1901, 1902
Pb, Ag
BIL
ML
TML
45°10'
GUYSBOROUGH CO
HALIFAX CO
LIMIT OF PRESENT MAPPING
BOUNDARY DEFINED BY AEROMAGNETIC SURVEY, G.S.C.
MILES
KILOMETRES
0
1
2
3
4
MAP AREA
HALIFAX
NOVA
60 mi
100 km
64°
62°
HORTON GROUP (CARBONIFEROUS)
undivided sandstone, shale and conglomerate
GRANITOID ROCKS (DEVONIAN - CARBONIFEROUS ?)
Eastern Lobe monozogranites (ELO)
South Loon Lake (SL), Nelson Lake (NL), Porcupine Lake (PL) and Moose Lake (ML) equigranular leucomonozogranites
Sanctuary (S) and East Loon Lake (ELL) megacrystic monozogranites
Twin Lake biotite granodiorite (TL)
GNEISSES AND MAFIC META-IGNEOUS ROCKS DEVONIAN (?)
meta-gabbro (Bog Island Lake - BIL) and mafic diatreme/breccia pipe (Ten Mile Lake - TML)
undivided high-grade gneisses and schists
MEGUMA GROUP (CAMBRO-ORDOVICIAN)
Mg
undivided slates, greywackes and metamorphic equivalents

Figure 1. Geological map of the Liscomb Complex, southern Nova Scotia.

The latter four plutons are grouped together as "leucocratic monzogranite" because as a group they appear remarkably similar despite local variations in xenolith contents and varying host rock lithologies. Similarly, the East Loon Lake and Sanctuary monzogranites have been grouped together as both are characterized by a medium- to coarse-grained megacrystic texture and have similar mineralogy and chemistry.

The *Twin Lake pluton* appears to be the oldest granitoid unit and is predominantly of granodioritic composition. The granodiorite is grey (colour index ranges from 5.0 to 12.91), medium- to coarse-grained and consists of 45-55% plagioclase, 20-25% quartz, 5-15% quartz, 5-15% alkali feldspar and 5-10% biotite. In a few samples the rock is devoid of alkali feldspar. Accessory minerals are muscovite, apatite, zircon, garnet, chlorites and opaques. Variations within the pluton are largely controlled by textural changes, proportions of minerals and xenoliths. No conclusions could be drawn regarding possible zoning in the pluton.

The *East Loon Lake* and *Sanctuary plutons* have been intruded by leucocratic monzogranites, aplitic dykes and quartz-tourmaline-garnet dykes. These megacrystic plutons, of predominantly biotite monzogranite composition, consist of 40-45% quartz, 15-25% plagioclase, 20-30% alkali feldspar, 5-10% phyllosilicates and less than 5% of accessory mineral phases (apatite, zircon, tourmaline, garnet, pyrite and ilmenite).

The *leucocratic monzogranites* occur both as discrete plutons and dykes cutting the Twin Lake, East Loon Lake and Sanctuary plutons and high-grade gneisses. They are equigranular and contain quartz, alkali feldspar and plagioclase as the essential mineral phases with subordinate amounts of phyllosilicates (muscovite > biotite), garnet, ilmenite, pyrite, and local minor chalcopyrite and sphalerite.

The *Eastern Lobe monzogranite* is fine grained along its western contact with Cambro-Ordovician Meguma Group sediments, becoming medium and even coarse grained with increasing distance from the contact. Thus, a crystallization/cooling history from the margin inwards is indicated. The essential minerals are quartz, alkali feldspar and plagioclase, with a fluctuating proportion of biotite and muscovite. Assessory minerals include apatite, zircon, tourmaline, garnet, Fe-Ti oxides and rare sphalerite.

To investigate the distribution of major and trace elements in the granitic rocks, a total of 48 samples were analyzed by XRF, INAA and AA. The Twin Lake granodiorite is represented by 12 samples, the megacrystic monzogranites of the East Loon Lake and Sanctuary Plutons by 12 samples, the leucocratic monzogranites by 11 samples from four plutons and the Eastern Lobe monzogranite by 13 samples.

The A/CNK index of the granitic rocks from the Liscomb Complex ranges from 1.14 to 1.35 and hence as a whole they are peraluminous. The variation diagrams shown in Figure 2 illustrate additional chemical characteristics of these granitic rocks:

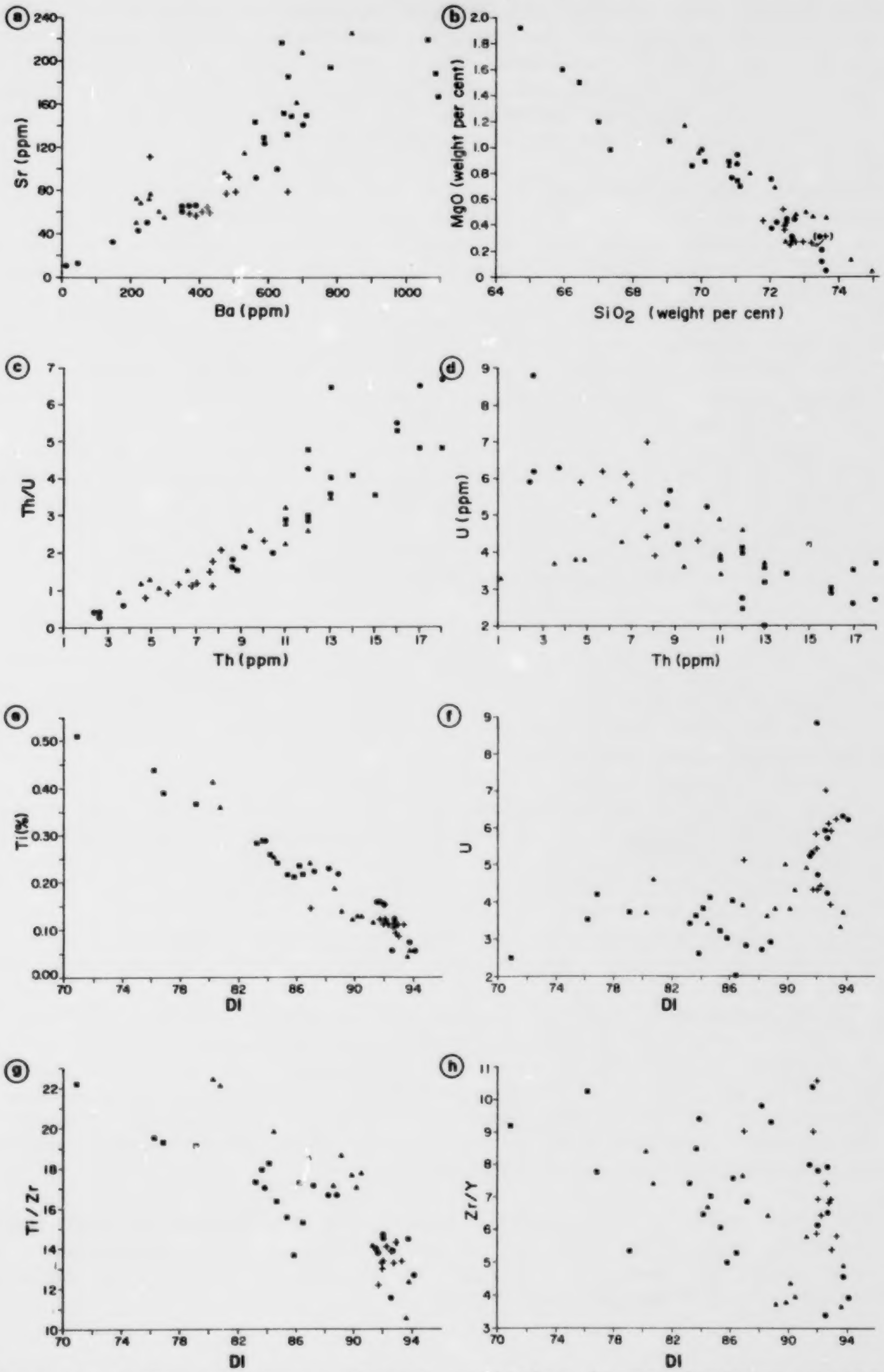

Figure 2. Major and trace element variation in peraluminous granites of the Liscomb Complex (solid square - Twin Lake granodiorite; solid triangle - megacrystic monzogranites, East Loon Lake and Sanctuary plutons; solid circle - Eastern Lobe monzogranites; cross - equigranular leucocratic monzogranites)

- strong positive and negative correlations between major and trace elements such as Ba vs Sr (Fig. 2a) and SiO_2 vs MgO (Fig. 2b); relationships clearly established in differentiated suites of peraluminous granites of the Meguma Zone,

- strong depletion of Th with decreasing Th/U in the granitic suite as a whole (Fig. 2c),

- marked increase in U with decreasing Th in the Eastern Lobe monzogranites (Fig. 2d),

- decrease in Ti with increasing differentiation index (DI) in the granitic suite as a whole (Fig. 2e)

From the above, it may be argued that the negative correlation of SiO_2 with MgO, DI with Ti and the positive correlation of Ba with Sr are all indicative of magmatic differentiation controlled to a large extent by fractional crystallization of biotite and plagioclase. However, other chemical features of our granitoid suite suggest that this simple model of differentiation from a single parental magma must be critically re-examined. Points to consider are as follows:

- a marked decrease in Th without significant uranium enrichment occurs in the Twin Lake pluton (granodiorite) and in the East Loon Lake/Sancturary plutons (megacrystic monzogranite) (Fig. 2d),

- the Th/U for Twin Lake granodiorite and Eastern Lobe monzogranites are similar for equivalent Th values (Fig. 2c),

- the insignificant U enrichment with increasing DI for the granodiorite and megacrystic monzogranite suites (Fig. 2f),

- the strong U enrichment with increasing DI for monzogranites of the Eastern Lobe (Fig. 2f),

- plotted against DI (Fig. 2e), the range in Ti content is greatest for the megacrystic monzogranites (0.36%), compared with 0.30% in the potentially cogenetic granodiorite, a relationship incompatible with simple magmatic differentiation.

These features suggest, alternatively that each pluton had its own crystallization history and that the initial trace element characteristics were largely controlled by source rock composition, degree of partial melting and other factors although the magmatic evolution was ultimately controlled by processes of fractional crystallization.

This suggestion can be further tested by considering the elemental ratios such as Ti/Zr and Zr/Y and the variation of these with the DI (Fig. 2g,h). It is clear that the Twin Lake granodiorite suite follows a distinct and separate evolutionary path from that of the East Loon Lake/Sanctuary megacrystic monzogranites, and that the latter have a higher Ti/Zr ratio than the granodiorites at equivalent DI values. This characteristic feature alone demonstrates that these monzogranites could not have derived solely from the differentiation of the granodiorite. Similarly, the Eastern Lobe monzogranites do not lie on either of these defined paths (Fig. 2g).

Because the leucocratic monzogranites have an extremely restricted Ti-Zr ratio, a characteristic shared by all highly differentiated monzogranites in our sample suite (Fig. 2g), the Zr/Y vs DI plot (Fig. 2b) is used to provide further insight. Similar Zr/Y values can be seen in both the granodiorites and megacrystic monzogranites and even in the most highly envolved leucomonzogranites. In addition, a linear trend appears on this diagram, defined by the leucomonzogranites, indicating clearly that the high silica rocks of the western lobe could not have been derived solely through differentiation of either the granodiorite or the megacrystic monzogranite suites.

In summary, field relationships, the recognition of discrete mappable plutonic bodies, and major and trace element chemistry lead to the following conclusions:

1. The peraluminous granite suite, high-grade felsic and mafic gneisses and mafic meta-igneous rocks are all part of the Liscomb Complex. The entire complex is disharmonic with its surroundings and therefore, considered post-tectonic with a diapiric emplacement mechanism.

2. The plutons are petrologically variable, each with its own evolutionary history. It is unlikely that all of the granitic rocks are products of differentiation from a single parental magma.

3. The four suites of granitic rocks show discrete differentiation trends, perhaps controlled by crystal fractionation of phases such as plagioclase, biotite, monazite and probably also Fe-Ti oxides.

4. Silica variation diagrams involving major and trace elements portray systmatic changes, but are not a definitive indicator of magmatic differentiation from a single parent magma.

5. The Th/U, Ti/Zr and Zr/Y ratios in combination with DI are important parameters with which the crystallization history of the plutons can be assessed. The ratios provide constraints on the interpretation of possible source rocks for the plutons. The nature of these source rocks may be fundamental to metallogenic specialization in the peraluminous granitoids of southern Nova Scotia as suggested by Chatterjee et al. (1983).

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GEOLOGY OF THE DEAN AND CHAPTER MANGANESE MINE AND SURROUNDING AREA, LUNENBURG COUNTY, NOVA SCOTIA*

G. A. O'Reilly

INTRODUCTION

The Nova Scotia Department of Mines and Energy carried out a diamond-drill program at the Dean and Chapter Manganese Mine located northeast of New Ross, Lunenburg County from October 1985 to February 1986 (Fig. 1). The program consisted of three drillholes designed to investigate for downward extensions of the known deposits at depths of 250, 550 and 1200 ft. (Fig. 2; O'Reilly, 1985). Two of the holes, D&C 85-1 and D&C 85-3, were geophysically surveyed for total gamma response.

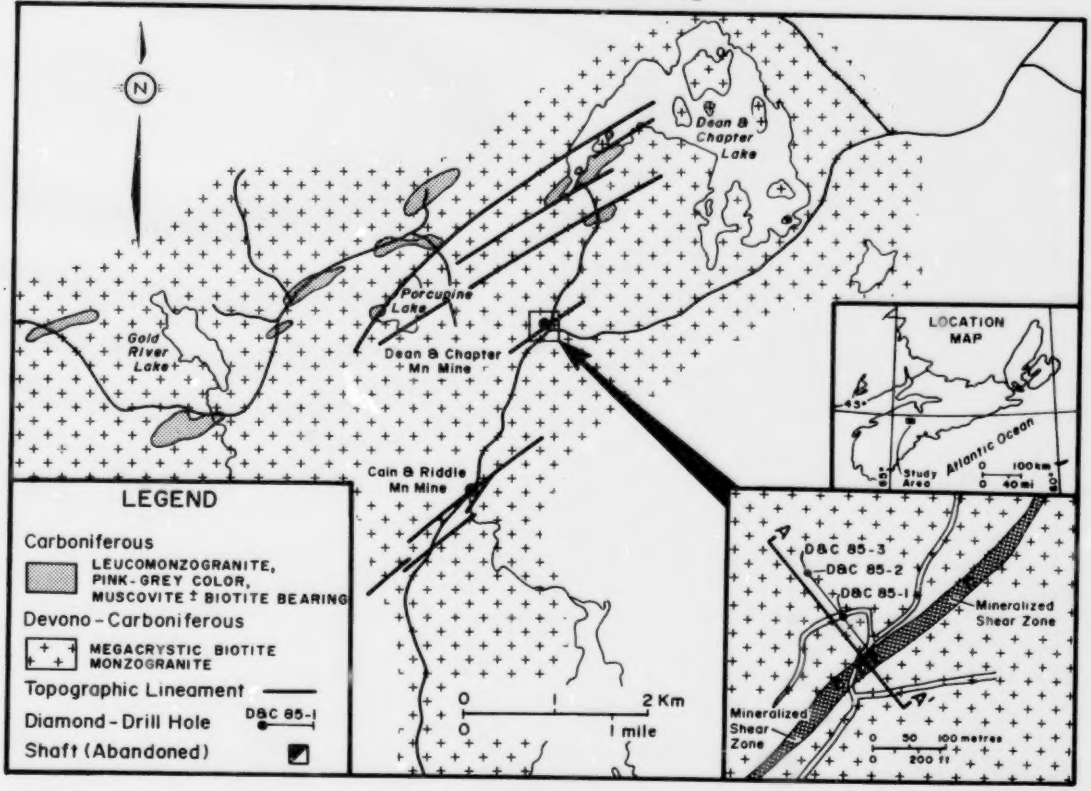
N
Dean & Chapter Lake
Porcupine Lake
Gold River Lake
Dean & Chapter Mn Mine
Cain & Riddle Mn Mine
LOCATION MAP
45°
Atlantic Ocean
Study Area
0 100km
0 40mi
LEGEND
Carboniferous
LEUCOMONZOGRANITE, PINK-GREY COLOR, MUSCOVITE ± BIOTITE BEARING
Devono-Carboniferous
MEGACRYSTIC BIOTITE MONZOGRANITE
Topographic Lineament
Diamond-Drill Hole
D&C 85-I
Shaft (Abandoned)
0 1 2 Km
0 1 mile
A
D&C 85-3
D&C 85-2
D&C 85-1
A'
Mineralized Shear Zone
Mineralized Shear Zone
0 50 100 metres
0 200 ft

Figure 1. Geology of the South Mountain Batholith in the vicinity of the New Ross Manganese Mines. Location recent diamond-drill holes at the Dean and Chapter Mine are given in the inset. Cross-section along A-A^1 is shown in Figure 2.

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*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

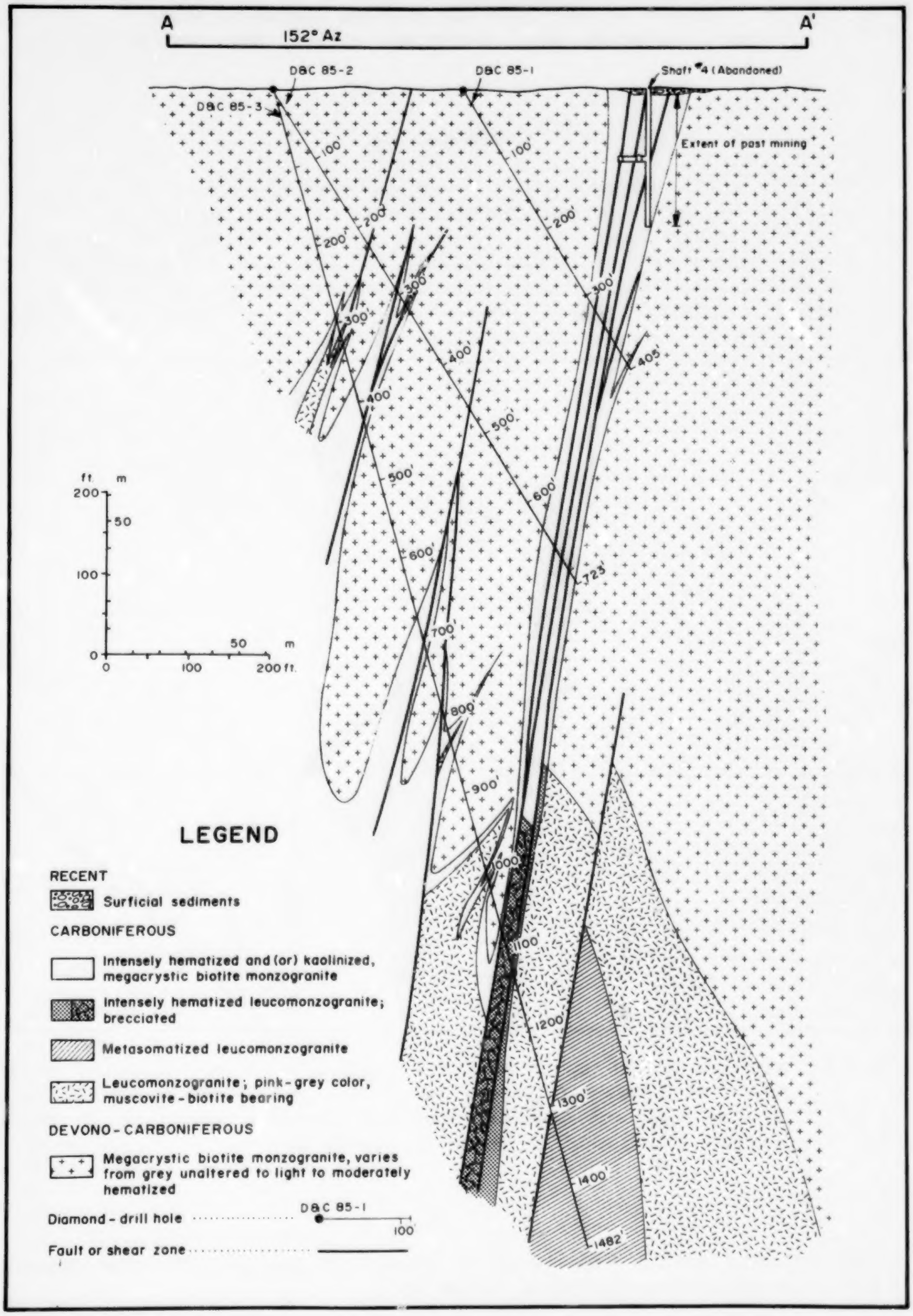
A
A'
152° Az
DBC 85-2
DBC 85-1
DBC 85-3
Shaft #4 (Abandoned)
Extent of past mining
100'
200'
300'
400'
405'
500'
600'
700'
723'
800'
900'
1000'
1100'
1200'
1300'
1400'
1482'
ft.
m
200
100
0
50
100
200 ft.
50
m
LEGEND
RECENT
Surficial sediments
CARBONIFEROUS
Intensely hematized and (or) kaolinized, megacrystic biotite monzogranite
Intensely hematized leucomonzogranite; brecciated
Metasomatized leucomonzogranite
Leucomonzogranite; pink-grey color, muscovite-biotite bearing
DEVONO-CARBONIFEROUS
Megacrystic biotite monzogranite, varies from grey unaltered to light to moderately hematized
Diamond-drill hole
DBC 85-1
100
Fault or shear zone

Figure 2. Cross-section of the Dean and Chapter Manganese Mine. Refer to Figure 1 for location.

During the past field season the core from the drilling project was logged at 1 cm = 5 ft and sampled in detail. The logging documented the spatial distribution of the various rock types and alteration facies resulting from fluid-rock interactions associated with the mineralization.

Upon completion of the core logging segment of the project the geology of the South Mountain Batholith in the vicinity of the manganese mines was mapped (Fig. 1). The various observed features associated with mineralization and hydrothermal alteration at the Dean and Chapter Mine were applied to the mapping. It is intended that this comparison will stimulate interest in the potential for similar or related mineral deposits in this and other areas of the batholith.

DRILLING RESULTS

The three holes collared in a cordierite-bearing, megacrystic biotite monzogranite. This phase forms both the hanging wall and footwall of the deposit and is typical of what underlies much of the South Mountain Batholith north of New Ross (MacDonald et al., this volume).

The monzogranite has been subjected to varying degrees of hematization throughout much of the length of the holes. During the logging of the holes this iron metasomatism was recorded as absent, light, moderate or intense according to color and degree of alteration of the pre-existing minerals. The unaltered monzogranite occurs as a fresh grey hypidiomorphic granular rock that with progressive hematization takes on a definite reddish tinge. The light to moderate hematized facies, for the most part, have no obvious structural control. The more heavily hematized rocks though, are invariably associated with features such as joints, shear zones, faults and veins.

DDH D&C 85-1

This drillhole intersected and cored the northeast trending mineralized zone at a vertical depth of 260 ft. This is a short distance below the past workings (200-230 ft). The zone persists to a downhole depth of approximately 380 ft and consists of such various intensely altered facies as kaolinized monzogranite, hematized and kaolinized monzogranite, and intensely hematized monzogranite. Manganese mineralization is associated with the most intensely hematized facies and occurs as massive lenses within breccia systems of hematite and ochre. Manganese oxides also occur as veinlets within a 4 ft thick silicified zone with a central core of quartz breccia.

DDH D&C 85-2

This drillhole intersected the zone at a true depth of approximately 550 ft. It passes through similar variably hematized facies of the megacrystic monzogranite encountered in the first hole. From 290 to 320 ft, a zone of intense hematization and brecciation surrounds a silicified and brecciated intrusion of pink-grey leucogranite.

The highly hematized and kaolinized zone corresponding to the mineralized zone in upper levels was intersected from 641 to 715 ft. Alteration facies similar to those observed in the zone in DDH 85-1 occur at this depth, except that kaolinization is less pure as it is usually accompanied by some degree of hematization. Hematite-ochre breccia and vein stockworks occur, but the pods and veinlets of Mn oxides observed in the previous hole are absent.

DDH D&C 85-3

This hole was angled to test the zone to a vertical depth of 1200 ft. Hematized monzogranite similar to that intersected in the previous holes dominates this hole to a downhole depth of 1085 ft. Zones of intense hematization and silicification are associated with minor intrusions of pink-grey leucogranite at 325, 695, 835 and 967 to 1010 ft.

From 1085 ft to total depth at 1482 ft the hole cored pink-grey leucogranite-leucomonzogranite. The contact between the megacrystic monzogranite and the leucomonzogranite is marked by 30 ft of highly hematized and brecciated leucomonzogranite indicative of brittle deformation. This is interpreted to be a fault zone which has also acted as a conduit for hydrothermal solutions resulting in the hematization. The last 170 ft of the hole is marked by various hematized and metasomatized facies of the leucomonzogranite which indicates that this region of the pluton has undergone considerable fluid-rock interaction.

RESULTS OF GEOLOGICAL MAPPING

The area in the vicinity of the New Ross Manganese Mines is, for the most part, underlain by the same megacrystic biotite monzogranite observed in the core from the drilling (MacDonald et al., this volume). A short distance north and west of the Dean and Chapter Mine, a number of small elongate plutons of pink-grey leucogranite-leucomonzogranite have intruded the megacrystic monzogranite. These plutons have a similar texture and composition to the leucogranite observed at depth below the Dean and Chapter Mine.

Air photo interpretation of this area of the batholith has shown that a pronounced system of northeast-southwest trending topographic lineaments occurs. These lineaments bear the same orientation as the mineralized zones at both the Dean and Chapter Mine and the Cain and Riddle Mine (Fig. 1). The orientations of the small leucogranite intrusions in the area of Gold River and Porcupine Lakes also coincide with this trend. This infers that these minor intrusions exploited this northeast-southwest trending megafracture or shear system. It is also apparent from the relations seen within the drill core and in the field mapping that there has been post-emplacement sinistral shearing of both the monzogranite and the leucogranites along this fracture system. The shear planes have allowed the passage of hydrothermal solutions resulting in the observed alterations and mineralization but it is not certain at this time whether the leucomonzogranite intrusions have played a direct or even an indirect role in the genesis of these solutions. Regardless of the origin of the solutions it is concluded from these observations that many of the lineaments shown on Figure 1 may have been affected by hydrothermal fluids in a like manner and thus have potential to host similar deposits.

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THE EAST KEMPTVILLE SN DEPOSIT: PRELIMINARY RESULTS FROM RECENT MAPPING*

D. J. Kontak, T. Mulja and R. Hingston

The East Kemptville tin mine, located in Yarmouth County, Nova Scotia, is currently the only primary producer of tin in North America. The deposit was discovered by Shell Canada Resources Limited in 1978 and subsequently purchased by Rio Algom Limited, who decided to proceed with development in October 1983. Based on the work of the exploration and mining staff of these companies a large tonnage (66 million tons), low grade (0.16% Sn) deposit was delineated with the Sn-Zn-Cu mineralization shown to be localized in the greisenized part of a leucogranite (Davis Lake Complex) near its contact with Lower Paleozoic metasedimentary rocks of the Meguma Group. Although a considerable amount of petrological data has been generated to characterize the mineralogical and chemical features of the deposit (Richardson et al., 1982; Richardson, 1983; Chatterjee and Strong, 1984), the ore zone had not been mapped. Thus, a project was initiated by the Nova Scotia Department of Mines and Energy in co-operation with Rio Algom Limited to produce a detailed map of the deposit. A condensed version of the 1:200 scale map (compiled during June-August, 1986) of the northern part of the deposit is presented in Figure 1 along with an outline of the ore zone as indicated by a contour of the 0.05% Sn grade (after Richardson et al., 1982). The following discussion, summarizing the results of the initial mapping, is considered preliminary and will no doubt be subject to modification after further work.

The area mapped is underlain by four dominant rock types, herein designated as metasediment, leucogranite, and blue and light/dark grey alteration facies of the granite. Subordinate amounts of silicified granite and a green sericite alteration facies are also represented. The metasediment is represented by massive, fine- to medium-grained quartzites. The leucogranite is characterized by the presence of moderately altered feldspars, euhedral muscovite, and a fine- to medium-grained hypidiomorphic texture. The dominant mineralogy is quartz, oligoclase-albite, orthoclase ± microcline, muscovite and andalusite. The alteration facies of the granite are recognized by the presence of distinct quartz 'eyes' (2-5 mm) set in a finer matrix and also by their distinctive colour (i.e. dark grey, blue, etc.) which reflects the changing hue of quartz, and presence or absence of topaz and variably coloured mica. It is noted that these rocks may contain considerable amounts of disseminated sulphides (pyrite, chalcopyrite) and fine grained cassiterite, in many cases contacts are gradational and the paragenetic sequence of alteration types remains to be established. The occurrence of pegmatites has been noted at two localities near the eastern granite metasediment contact but there is a notable absence of microlitic cavities in the leucogranite. Although samples of kaolinized rock are found in muck piles, this unit did not outcrop in the map area.

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*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

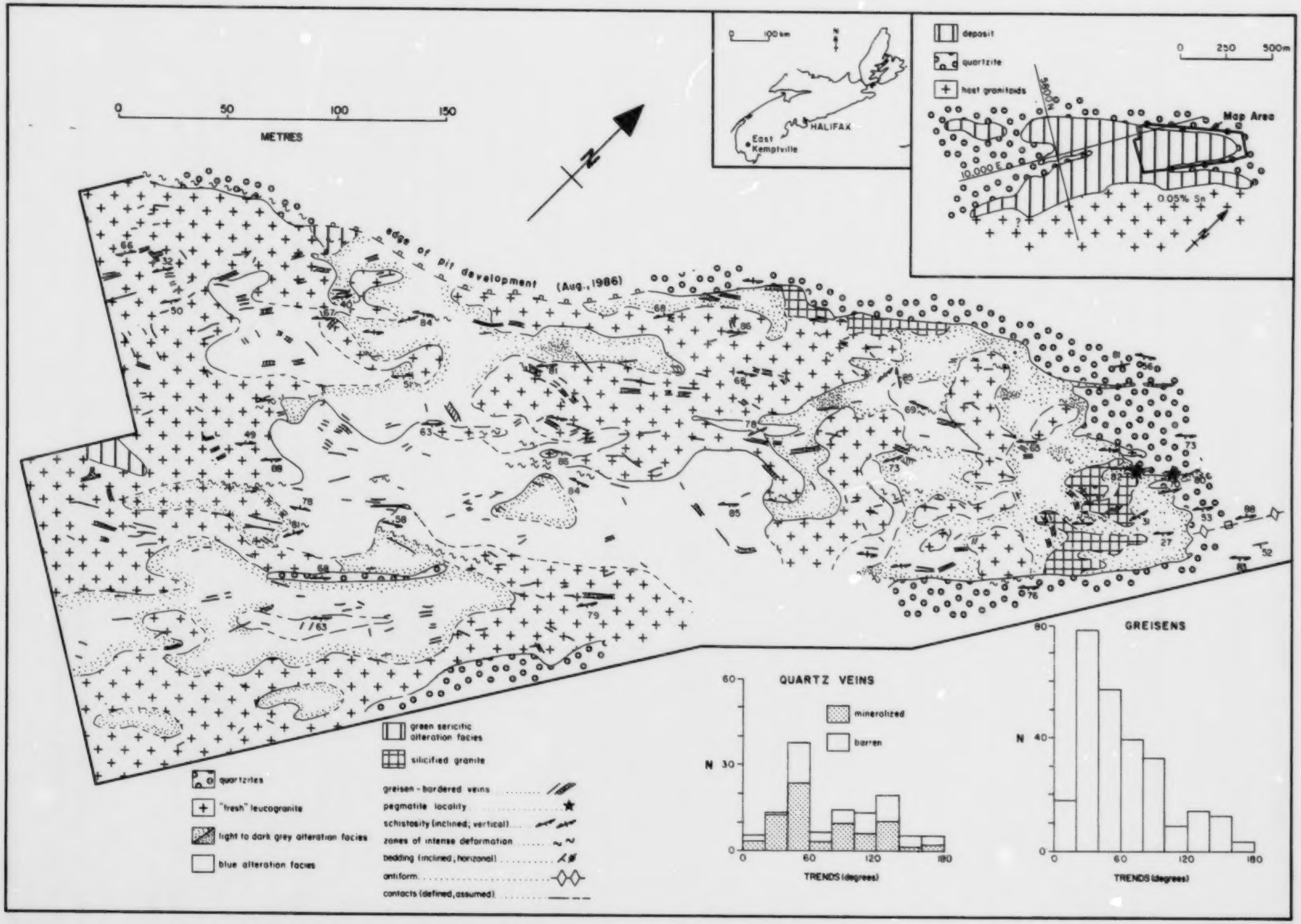

0
50
100
150
METRES
N
100 km
HALIFAX
East Kemptville
deposit
quartzite
host granitoids
0
250
500m
5800 N
10,000 E
Map Area
0.05% Sn
edge of pit development (Aug., 1986)
quartzites
"fresh" leucogranite
light to dark grey alteration facies
blue alteration facies
green sericitic alteration facies
silicified granite
greisen - bordered veins
pegmatite locality
schistosity (inclined; vertical)
zones of intense deformation
bedding (inclined, horizontal)
antiform
contacts (defined, assumed)
QUARTZ VEINS
mineralized
barren
N
0
30
60
0
60
120
180
TRENDS (degrees)
GREISENS
N
0
40
80
0
60
120
180
TRENDS (degrees)

Figure 1. Surface (|106 m level) geological map of the northeastern part of the East Kemptville open pit mine. The inset diagram (after Richardson et al., 1982) shows the outline of the deposit as delineated by the 0.05% Sn grade contour and location of the map area. Note that the fabrics shown in the granitoids represent the shear fabric (C plane) only.

The various granitoid units are cut by numerous greisen zones of variable width (generally 10 cm to 1 to 2 m) and length, which are cored by cassiterite-topaz veins (see Richardson, 1983, for a thorough description). The greisens are generally steeply dipping with a considerable range of strike orientation (inset, Fig. 1) and are found in all the granitoid units, although within the map area they are apparently concentrated within the leucogranite. It is these greisens which contain the majority of the tin and certainly the highest grades. At present it is not known if there is a vertical zonation within these greisen zones and what is represented at depth beneath the ore zone.

Abundant paragentically late stage, quartz-sulphide ± fluorite ± triplite ± apatite ± clays ± carbonate veins of similar orientation as the greisens (Fig. 1) also cut the granitoids, although those hosted by the blue alteration facies are notably devoid of sulphides. Within the main sulphide stage of mineralization, sphalerite represents the dominant phase with chalcopyrite second in abundance.

Structural elements within the map area appear to be of two ages. The older of these, developed in metasedimentary rocks, is represented by a tightly folded, upright, northeast-southwest trending antiform having a subhorizontal fold axis and steep to upright foliation. A subsequent variably penetrative, shearing event caused intense deformation of the granitoid units with considerable grain size reduction and the development of steep northeast-southwest trending C-S fabrics. Locally, shear zones of 0.1-1.0 m width have developed (Fig. 2), displaying a dextral sense of displacement. In some cases the sense of mineral rotation indicates a considerable component of vertical movement. Thin (1-10 cm) zones of ultramylonite represent the intense shearing found within both the granitic and metasedimentary units. The age of this shear-related deformation has not been firmly established, but textural evidence, as observed from field relationships and petrographic studies, suggests it may overlap granitoid emplacement and mineralization. Thus, a prolonged history of ductile shearing within this zone is required.

Chemical data for the various granitoid units are presented in tabular form in Figure 3. The data have been normalized to permit graphic portrayal of the information and hence direct comparisons can be made among the different rock types. The following points are noted:

(i) compared to Tischendorf's (1977) specialized granite the leucogranite (average of 8 analyses) is relatively enriched in P_2O_5, Rb, F, Sn and depleted in Fe_2O_3(T), CaO, K_2O and Li;

(ii) all the rocks except the biotite granite, show substantial enrichment in Sn, P_2O_5 and F;

(iii) although the altered granites have elevated U contents (to 30 ppm) no further concentration occurred;

(iv) the Sn values are highly variable with a general correlation with P_2O_5, Zn, Cu and F apparently present (Chatterjee and Strong, 1984);

(v) although the higher tin contents are generally found in the darker, greisen-bordered alteration selvedges to the quartz-cassiterite-topaz veins (samples 005, 007, 016 in Fig. 3b), substantial amounts of finer grained, pargenetically earlier tin is found in the other units (Fig. 3a).

Thus, on the scale of the deposit, the amount of tin located in the granitoid rocks hosting the tin-rich greisen zones is considerable.

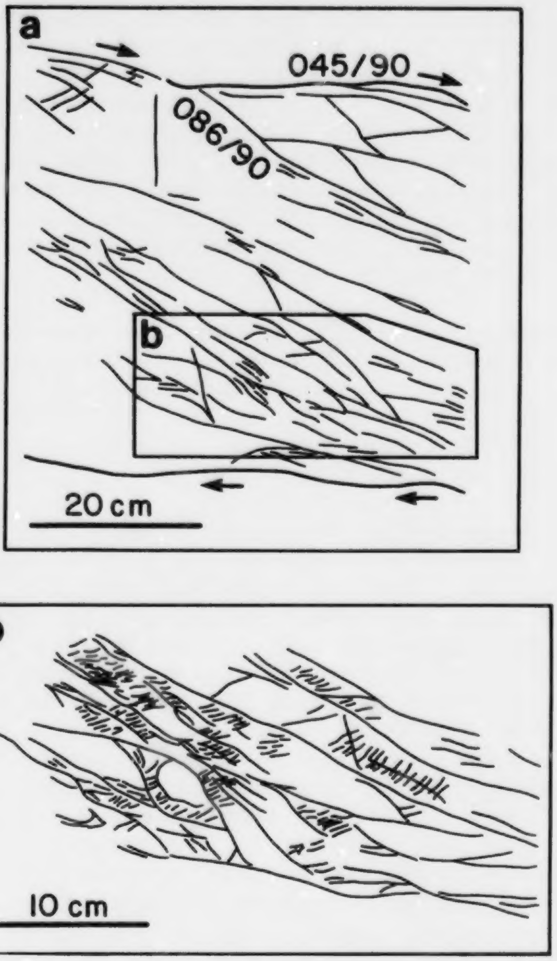


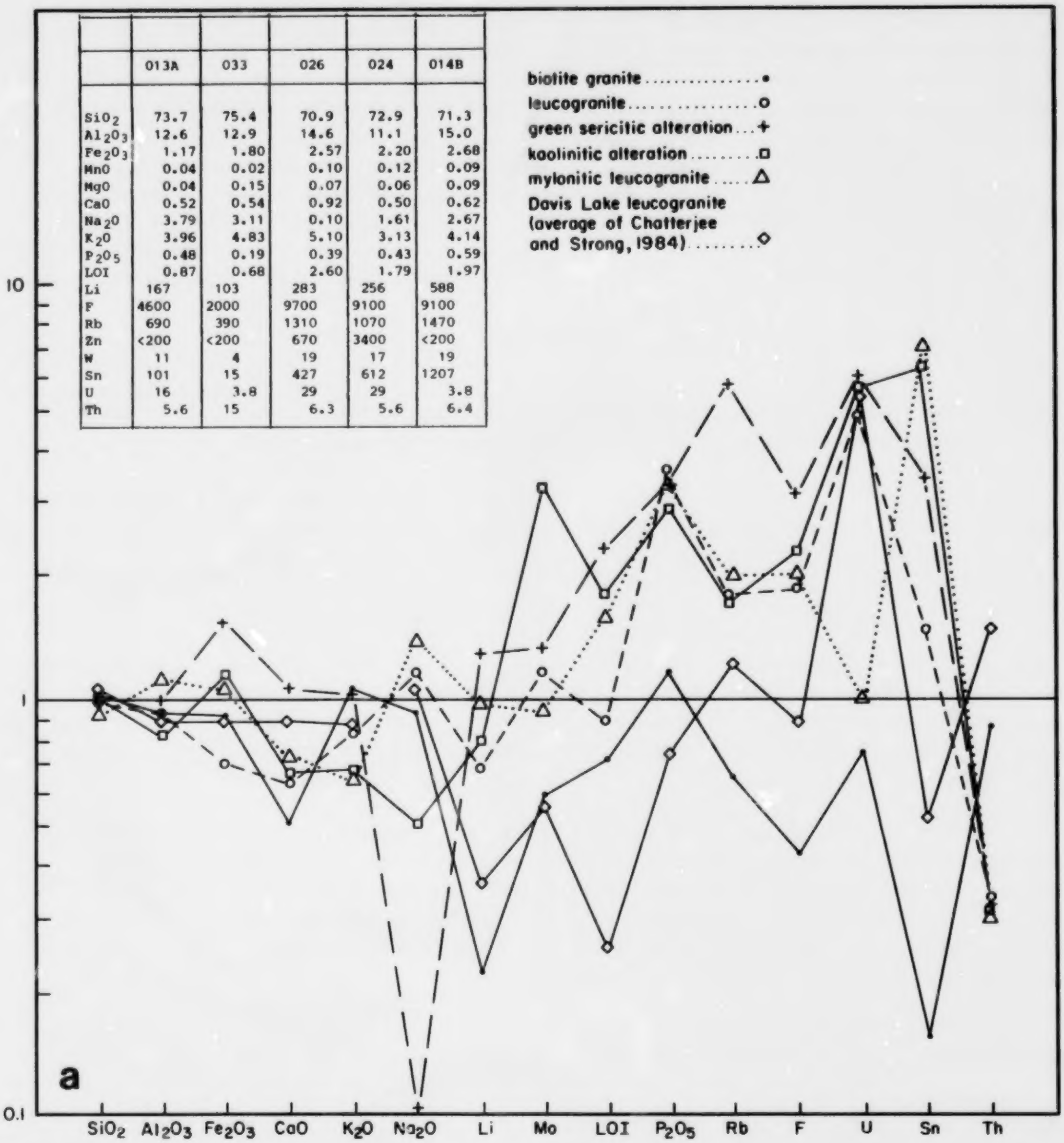
Figure 2. (a) Photographic trace of a shear zone with dextral displacement developed within the light grey altered facies of the granite.

(b) Enlarged position of Figure 2a showing the presence of a third fabric within the shear zone. This fabric is interpreted to represent an early compressional fabric (S plane) with the other fabrics being shear-related.

The foregoing discussion indicates that although the East Kemptville deposit is clearly of the greisen type (following Shcherba, 1970, although the pegmatitic stage is lacking) and is apparently related spatially to a highly evolved leucogranite, some problems remain to be addressed. The following points are emphasized:

(i) the presence of penetrative deformation of questionable age (both pre- and post-mineralization) means that the significance of published Ar-Ar muscovite ages of ca. 295 Ma for the deposit (Zentilli and Reynolds, 1985) may have to be reassessed;

(ii) the coincidence of the attitudes for the greisens, quartz ± sulphide veins and structural fabrics may suggest a common origin(?);

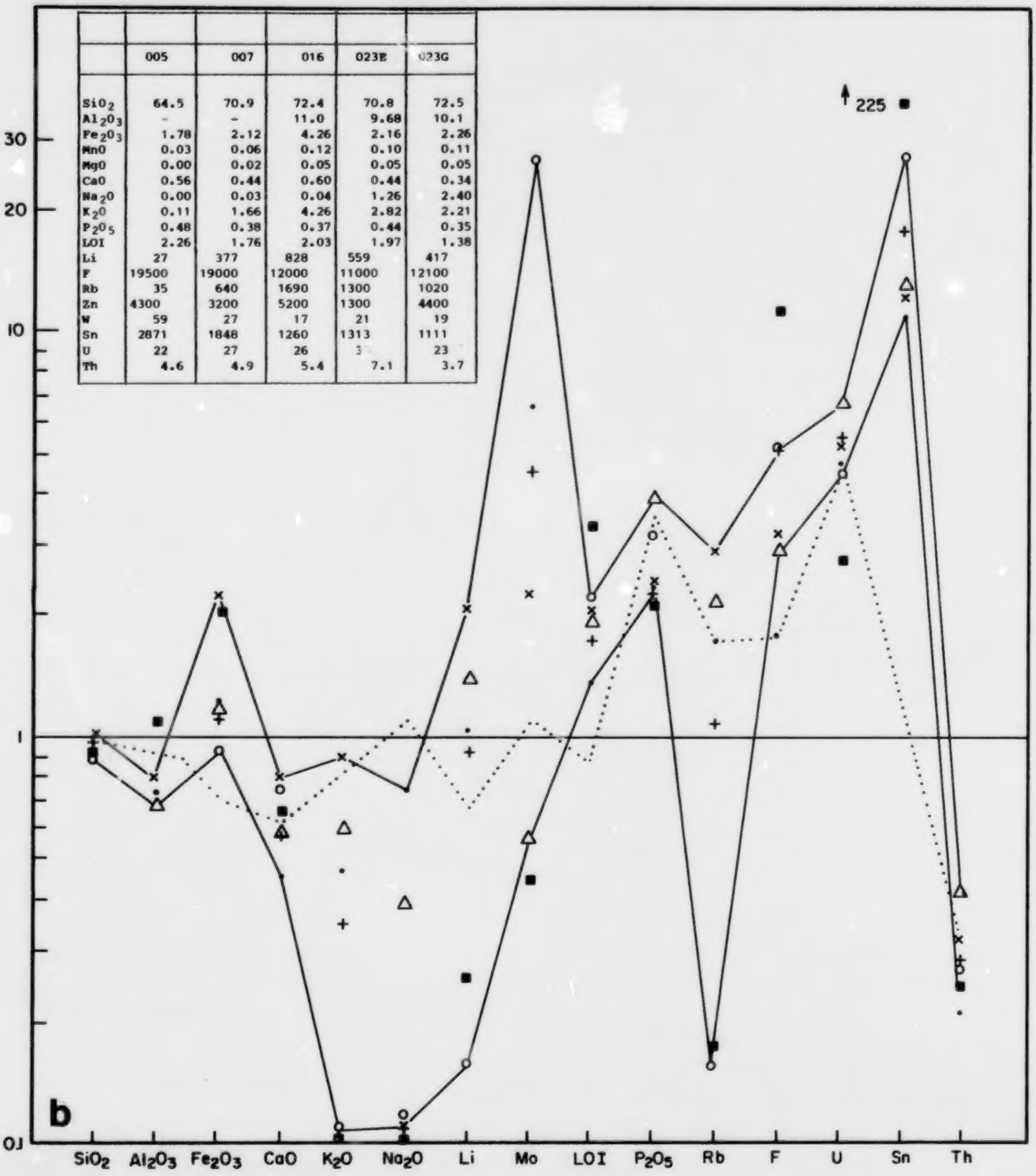


	013A	033	026	024	014B
SiO_2	73.7	75.4	70.9	72.9	71.3
Al_2O_3	12.6	12.9	14.6	11.1	15.0
Fe_2O_3	1.17	1.80	2.57	2.20	2.68
MnO	0.04	0.02	0.10	0.12	0.09
MgO	0.04	0.15	0.07	0.06	0.09
CaO	0.52	0.54	0.92	0.50	0.62
Na_2O	3.79	3.11	0.10	1.61	2.67
K_2O	3.96	4.83	5.10	3.13	4.14
P_2O_5	0.48	0.19	0.39	0.43	0.59
LOI	0.87	0.68	2.60	1.79	1.97
Li	167	103	283	256	588
F	4600	2000	9700	9100	9100
Rb	690	390	1310	1070	1470
Zn	<200	<200	670	3400	<200
W	11	4	19	17	19
Sn	101	15	427	612	1207
U	16	3.8	29	29	3.8
Th	5.6	15	6.3	5.6	6.4

biotite granite .... •
leucogranite .... o
green sericitic alteration ... +
kaolinitic alteration .... □
mylonitic leucogranite ..... △
Davis Lake leucogranite (average of Chatterjee and Strong, 1984) .... ◇
10
1
0.1
a
SiO2
Al2O3
Fe2O3
CaO
K2O
Na2O
Li
Mo
LOI
P2O5
Rb
F
U
Sn
Th

Figure 3. Chemical data for various granitoid facies from the East Kemptville tin deposit. Data have been normalized to the following values: (i) Tischendorf's (1977) specialized or stannigene granite for the major elements, F, Li, Rb and Mo; (ii) Taylor's (1966) average crustal abundances for U and Th; and appropriate values for Sn (100 ppm) and LOI (loss on ignition = 1 wt. %) for purposes of plotting the data.

(a) Representative chemical data and normalized patterns (average of two samples except for the leucogranites in which eight analyses are averaged) for various granitoid rocks; Note that the biotite granite comes from southeast of the deposit area but similar rocks occur as large boulders in till overlying bedrock within the deposit area.



	005	007	016	023E	023G
SiO_2	64.5	70.9	72.4	70.8	72.5
Al_2O_3	-	-	11.0	9.68	10.1
Fe_2O_3	1.78	2.12	4.26	2.16	2.26
MnO	0.03	0.06	0.12	0.10	0.11
MgO	0.00	0.02	0.05	0.05	0.05
CaO	0.56	0.44	0.60	0.44	0.34
Na_2O	0.00	0.03	0.04	1.26	2.40
K_2O	0.11	1.66	4.26	2.82	2.21
P_2O_5	0.48	0.38	0.37	0.44	0.35
LOI	2.26	1.76	2.03	1.97	1.38
Li	27	377	828	559	417
F	19500	19000	12000	11000	12100
Rb	35	640	1690	1300	1020
Zn	4300	3200	5200	1300	4400
W	59	27	17	21	19
Sn	2871	1848	1260	1313	1111
U	22	27	26	[illegible]	23
Th	4.6	4.9	5.4	7.1	3.7

Figure 3. Chemical data for various granitoid facies from the East Kemptville tin deposit. Data have been normalized to the following values: (i) Tischendorf's (1977) specialized or stannigene granite for the major elements, F, Li, Rb and Mo; (ii) Taylor's (1966) average crustal abundances for U and Th; and appropriate values for Sn (100 ppm) and LOI (loss on ignition = 1 wt. %) for purposes of plotting the data.

(b) Representative chemical data and their normalized patterns for dark grey greisens; dotted pattern represents the leucogranite in Figure 3a for comparison and the square is a quartz-topaz-cassiterite greisen from Richardson (1983).

(iii) the relationship between the early, widespread development of a variety of alteration facies and the main stanniferous depositing event represented by the greisens;

(iv) the ultimate source of the host granite and mineralizing fluids especially in light of the numerous other localities hosting tin mineralization in southwest Nova Scotia (Chatterjee, 1983);

(v) what happens to the mineralized veins in the vertical dimension (i.e. why is it apparently confined to the upper 100 m and is it zoned); and

(vi) at what depth did it form.

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MEGUMA GOLD STUDIES: ADVANCES IN GEOLOGICAL INSIGHT AS AN AID TO GOLD EXPLORATION*

P. K Smith and D. J. Kontak

Thirty gold deposits, all located in the eastern portion of the Cambro-Ordovician Meguma Terrane of Nova Scotia (Fig. 1), were examined in various degrees of detail in order to assess their characteristics and to establish a hierarchy of genetically important features which may prove beneficial in exploration. Important features observed and documented at the deposits included alteration, vein morphology and texture, ore paragenesis, metamorphism, structure and lithology. From the database being compiled it is our objective to establish unique criteria by which individual gold districts can be classified. Aspects of all deposits were compared with specific features observed in surface exposure and(or) drill core from Beaver Dam, Cochrane Hill, Forest Hill, Goldenville and Mooseland where there is abundant information. Drill core from the Beaver Dam deposit (with current published reserves of 1.64 million tons of 0.34 oz Au/ton) was examined to determine the local stratigraphy and its continuity in mineralized zones. The results of these preliminary field-based studies are discussed below and their implications for mineral exploration assessed.

Within all the gold districts** there are pronounced **alteration zones,** the most prominent being a silica alteration halo surrounding the auriferous zones. The extent and intensity of this alteration is variable from deposit to deposit, although there is generally a positive correlation of alteration intensity and size of individual ore deposits (Table 1). The silicified zones vary in width from several mm to 10s of m on either side of the richest mineralized horizons. The intensity of silicification varies from barely detectable to complete replacement of sandstone lithologies culminating in the formation of granular-textured quartz veins, frequently displaying irregular but sharp wall-rock contacts. Other alteration types (e.g. phyllic and carbonate) developed within these gold deposits will be described in more detail in a subsequent publication.

Another notable feature common to each deposit is the composite nature of the **quartz veins** and the intricate inter-relationships of the various vein types. As a generalization, the veins represent a complete relative age spectrum, commencing with the onset of penetrative deformation and culminating sometime after the deformation of Devono-Carboniferous plutons in the area.

The **textural/morphological features** of quartz in the different veins (Table 1) represent a variety of types. It should be noted however that

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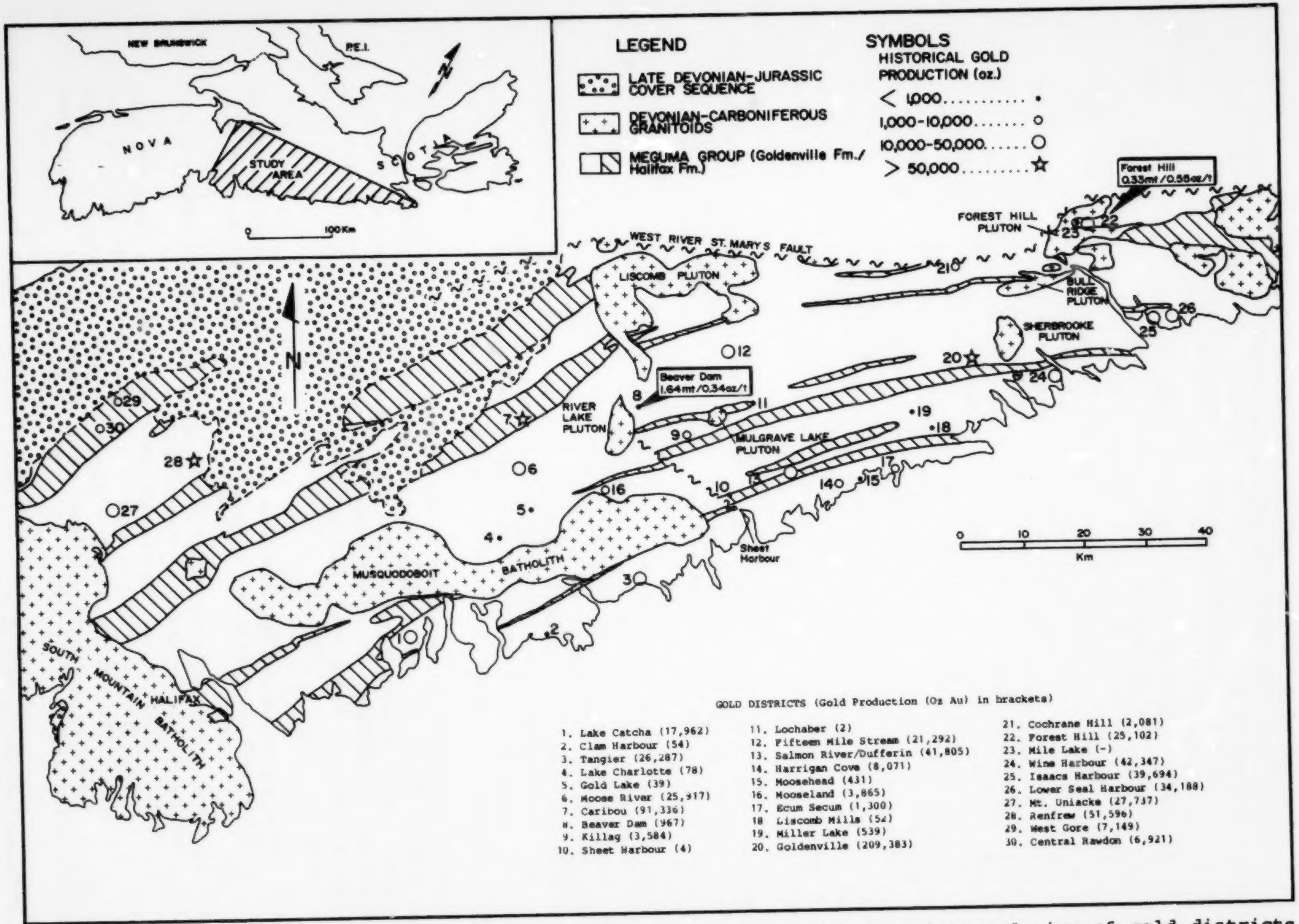
*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

**The term gold district is herein defined as areas of former gold producers irrespective of their historical production. The size of the areas vary from a few old dumps with limited exposure to relatively large regions of recently stripped outcrop with accessible drill core and underground workings.


NEW BRUNSWICK
P.E.I.
N
NOVA SCOTIA
STUDY AREA
0 100Km
LEGEND
LATE DEVONIAN-JURASSIC COVER SEQUENCE
DEVONIAN-CARBONIFEROUS GRANITOIDS
MEGUMA GROUP (Goldenville Fm./ Halifax Fm.)
SYMBOLS
HISTORICAL GOLD PRODUCTION (oz.)
< 1,000 ●
1,000-10,000 ○
10,000-50,000 ○
> 50,000 ☆
Forest Hill 0.33mt/0.58oz/t
FOREST HILL PLUTON
WEST RIVER ST. MARY'S FAULT
LISCOMB PLUTON
BULL RIDGE PLUTON
SHERBROOKE PLUTON
Beaver Dam 1.64mt/0.34oz/t
RIVER LAKE PLUTON
MULGRAVE LAKE PLUTON
MUSQUODOBOIT BATHOLITH
Sheet Harbour
SOUTH MOUNTAIN BATHOLITH
HALIFAX
N
0 10 20 30 40
Km
1
2
3
4
5
6
7
8
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GOLD DISTRICTS (Gold Production (Oz Au) in brackets)
1. Lake Catcha (17,962)
2. Clam Harbour (54)
3. Tangier (26,287)
4. Lake Charlotte (78)
5. Gold Lake (39)
6. Moose River (25,917)
7. Caribou (91,336)
8. Beaver Dam (967)
9. Killag (3,584)
10. Sheet Harbour (4)
11. Lochaber (2)
12. Fifteen Mile Stream (21,292)
13. Salmon River/Dufferin (41,805)
14. Harrigan Cove (8,071)
15. Moosehead (431)
16. Mooseland (3,865)
17. Ecum Secum (1,300)
18 Liscomb Mills (54)
19. Miller Lake (539)
20. Goldenville (209,383)
21. Cochrane Hill (2,081)
22. Forest Hill (25,102)
23. Mile Lake (-)
24. Wine Harbour (42,347)
25. Isaacs Harbour (39,694)
26. Lower Seal Harbour (34,188)
27. Mt. Uniacke (27,737)
28. Renfrew (51,596)
29. West Gore (7,149)
30. Central Rawdon (6,921)

Figure 1. Generalized geological map of the Eastern Meguma Zone with locations and size of gold districts examined in this study. The historical production of gold (indicated in ounces) for the various districts is from Nova Scotia Department of Mines and Energy. Information Series No. 37 (Bates, in press)

Table 1. Comparative table showing variation of specific structural, metamorphic and mineralogical features of some gold districts in southeastern Nova Scotia.

GOLD DEPOSIT OR DISTRICT EXAMINED	WALL ROCK ALT[1]			DOMINANT VEIN TYPES[2]							ORE MINERALOGY									VEIN GANGUE MINERALOGY[3]									METAMORPHISM[4]					STRUCTURE					PRODUCTION (oz Au)	
																													REGIONAL			CONTACT		HINGE	LIMB	OVERTURNED	SHEAR	MINERAL LINEATION	<20,000	>20,000
	S	M	W	A	B	C	D	E	F	O	Ag	Au	As	W	Cu	Pb	Zn	Mo	Sb	Qtz	Ca	Ch	Mu	Bi	Gt	Pl	Ad	Hb	Ch	Bi	St	P	A							
1. Lake Catcha	x				x		x		x			x	x		x	x	x			x	x	x	x						x				x	x	x			x	x	
2. Clam Harbour			x	x	x		x					x	x		x	x	x			x	x	x	x	x						x			x	x	x			x	x	
3. Tangier			x	x	x		x		x			x	x		x	x	x			x	x	x	x							x			x	x			x	x		x
4. Lake Charlotte		x			x				x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x		x		x			x		x	x		x	x	
5. Gold Lake		x		x	x		x		x			x	x		x	x	x			x	x	x								x			x		x		x	x	x	
6. Moose River		x		x	x		x		x		x	x	x	x	x	x	x			x	x	x	x							x			x	x	x			x		x
7. Caribou	x			x	x		x		x	x		x	x		x	x	x	x	x	x	x	x	x							x			x	x	x			x		x
8. Beaver Dam	x			x	x	x	x		x			x	x	x	x	x	x	x		x	x	x	x	x	x	x	x			x			x		x	x	x	x	x	
9. Killag		x		x	x		x		x	x		x	x		x	x	x			x	x	x	x							x			x		x	x		x	x	
10. Sheet Harbour			x		x		x					x	x		x					x	x								x				x		x				x	
11. Lochaber			x		x		x					x	x			x	x			x	x								x				x		x			x	x	
12. Fifteen Mile Stream	x			x	x		x		x			x	x		x	x	x			x	x	x	x	x		x				x			x	x	x				x	
13. Salmon River/Dufferin		x			x		x		x			x	x		x	x	x			x	x	x	x			x				x			x		x			x		x
14. Harrigan Cove			x	x	x		x		x			x	x							x	x	x	x	x		x				x			x		x	x			x	
15. Moosehead			x	x	x		x					x	x		x	x	x			x	x	x	x							x			x		x			x	x	
16. Mooseland			x	x	x	x	x		x	x		x	x	x						x			x	x		x					x	x		x	x		x	x	x	
17. Ecum Secum		x		x	x		x		x			x	x		x	x	x			x	x	x	x						x				x	x	x		x		x	
18. Liscomb Mills			x				x		x			?								x									x				x		x				x	
19. Miller Lake		x		x	x		x		x			x	x		x	x	x			x	x	x	x						x				x		x				x	
20. Goldenville	x			x	x	x	x		x			x	x		x	x	x			x	x	x	x							x			x	x	x	x	x	x		x
21. Cochrane Hill	x			x	x	x	x	x	x			x	x		x	x	x			x	x	x	x	x	x	x	x	x			x		x		x	x	x	x	x	
22. Forest Hill	x			x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x		x
23. Mile Lake		x		x	x	x	x	x	x			x	x		x	x	x			x		x	x	x	x	x		x			x	x			x	x	x	x	x	
24. Wine Harbour		x			x		x		x			x	x		x	x	x			x	x	x	x						x				x		x					x
25. Isaacs Harbour			x	x	x		x		x	x		x	x		x	x	x			x	x	x	x						x				x	x	x					x
26. Lower Seal Harbour		x		x	x		x		x			x	x		x	x	x			x	x	x	x							x			x	x	x		x	x		x
27. Mt. Uniacke		x		x	x	x	x		x		x	x	x		x	x	x			x	x	x	x	x						x			x		x	x	x	x		x
28. Renfrew		x		x	x		x		x			x	x		x	x	x	x		x	x	x	x						x				x		x		x	x		x
29. West Gore								x	x		x	x	x		x	x	x		x	x	x								x				x		x		x		x	
30. Central Rawdon		x			x		x		x		x	x	x							x	x	x	x										x		x				x	

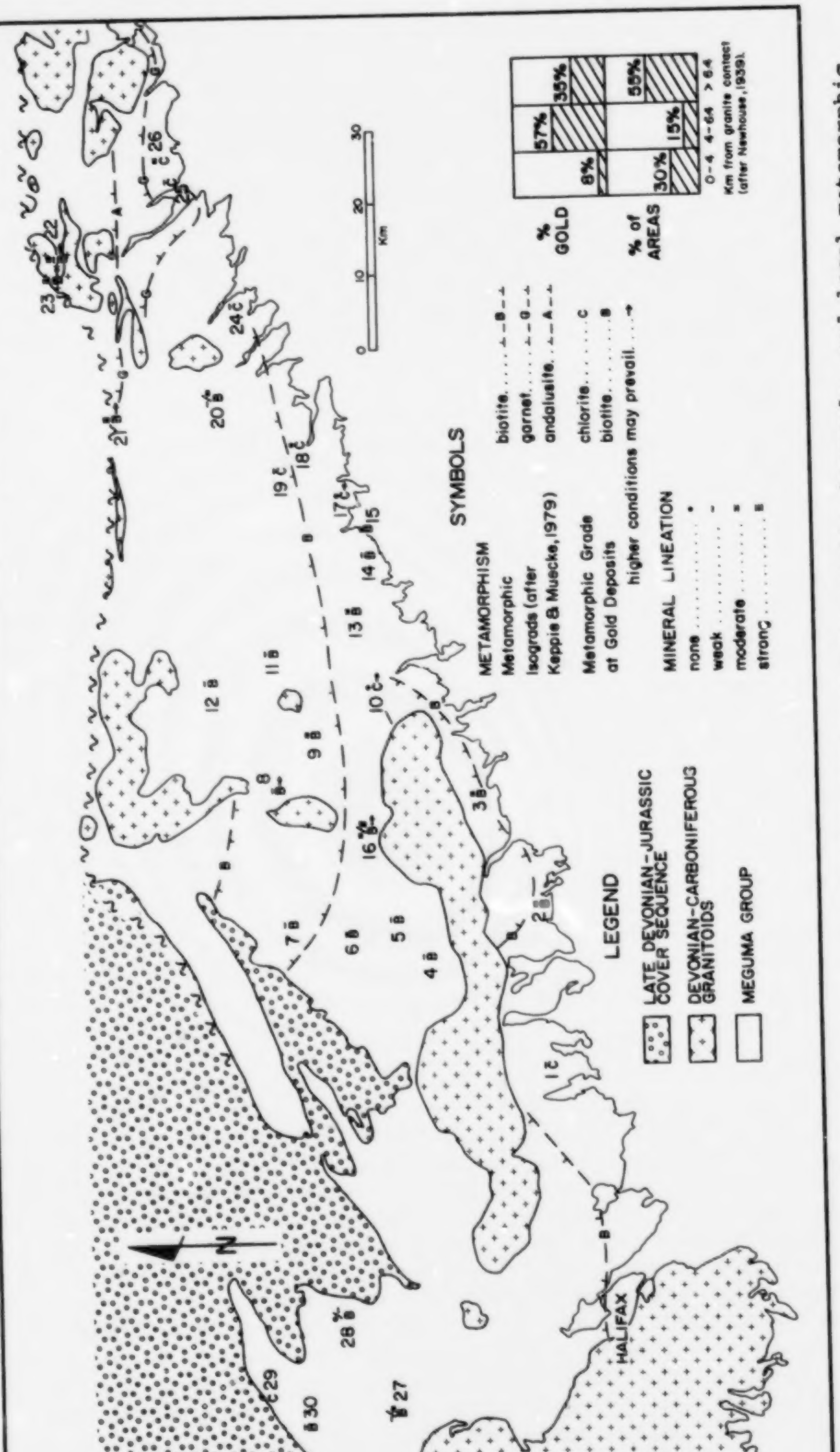
[1] wall rock alteration: strong (S), medium (M), weak (W)
[2] dominant vein types: A to F after Smith (1983), O = other types
[3] vein gangue mineralogy: quartz (Qtz), carbonate (Ca), Chlorite (Ch), biotite (Bi), garnet (Gt), plagioclase (Pl), andalusite (Ad), amphibole (Hb)
[4] metamorphism: chlorite grade (Ch), biotite grade (Bi), garnet-staurolite-cordierite grade (St); contact metamorphism: present (P), absent (A)

all types are not necessarily found in every deposit. These vein textures include very coarse euhedral quartz displaying common vugs (open or filled), platey quartz, and medium- to fine- grained granular or saccharoidal quartz. Individual quartz crystals in the vuggy textured veins may vary from mm size up to 40 cm in length. Plagioclase, chlorite and carbonate ± sulphides are most common as late stage vug infillings. Platey quartz is typical of many concordant veins displaying columnar-like or crack-seal type textures. Granular or saccharoidal textured quartz is least common and occurs primarily in psammitic lithologies where silicification is most intense.

Previous descriptions of the **ore mineralogy** within these gold districts documents a relatively simple assemblage with arsenopyrite, pyrrhotite and pyrite comprising the dominant sulphide phases. Lesser amounts of native gold and silver, argentite, tetrahedrite, galena, chalcopyrite, sphalerite, loellingite, scheelite, molybdenite and stibnite have been identified. However, additional petrographic studies are defining other accessory mineral phases in the ore zones. At present most gold is believed to occur in its native form within vein quartz (60%), with the remainder at vein wall rock contacts (20%), as silicate/sulphide inclusions (15%) and as fine disseminations in host rock lithologies.

The chlorite-biotite **metamorphic** isograd has been regarded by some authors (Mawer, in preparation; Graves, 1976) as representing the optimum metamorphic conditions for gold deposition. However, many of the gold districts are located above this metamorphic isograd (Fig. 2) and display anomalous mineral assemblages which indicate substantially higher metamorphic temperatures. For example, at the Beaver Dam and adjacent properties, biotite porphyroblasts give way to garnet + andalusite ± cordierte ± staurolite assemblages with increasing depth. This is interpreted as reflecting the presence of a thermal dome associated with the migration of hydrothermal fluids during mineralization. Although there does not appear to be significant contact metamorphic effects associated with the majority of the gold districts (Table 1, Fig. 2), the occurrence of elevated metamorphic conditions may suggest plutonism at depth below some of these mineralized areas (e.g. Cochrane Hill deposit, Smith, 1983). The proximity of gold deposits to granitic rocks is a feature first recognized by Newhouse (1936; inset in Fig. 1), but a possible genetic link between the two has since been ignored.

Structural elements within the southeastern Meguma Terrane record five stages of deformation (Smith, 1983; O'Brien, 1983; Keppie, 1983; Smith et al., 1985) although all these fabrics have not been observed within individual gold districts. The D_1 event (Smith et al., 1985) is generally difficult to discern due to poor exposure in most districts. D_2, the major folding event is always present, as are D_5 structures, while D_3 and D_4 fabrics appear to be sporadically developed. Fifteen Mile Stream, Forest Hill and Cochrane Hill offer good examples of the S_3 subhorizontal biotite banding while Mt. Uniacke, Tangier, Gold Lake, Beaver Dam, Cochrane Hill, Forest Hill and others (Table 1) display variably penetrative, upright S_4 shear cleavage.


N
HALIFAX
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LEGEND
LATE DEVONIAN-JURASSIC COVER SEQUENCE
DEVONIAN-CARBONIFEROUS GRANITOIDS
MEGUMA GROUP
SYMBOLS
METAMORPHISM
Metamorphic Isograds (after Keppie & Muecke, 1979)
biotite .... B
garnet .... G
andalusite .... A
Metamorphic Grade at Gold Deposits
chlorite c
biotite .... B
higher conditions may prevail
MINERAL LINEATION
none
weak
moderate
strong
0 10 20 30
Km
% GOLD
% of AREAS
8%
57%
35%
30%
15%
55%
0-4 4-64 >64
Km from granite contact (after Newhouse, 1939)

Figure 2. Generalized geological map showing regional metamorphic isograds and local metamorphic and structural data for gold districts. Numbers refer to gold districts given in Figure 1.

Within most of the gold districts there is a well developed vertical mineral lineation (Table 1) defined by carbonate, biotite or andalusite. In all cases (except Forest Hill) this lineation pitches vertically on a steep east-west striking cleavage plane. This preferred mineral lineation displays syntectonic growth during cleavage development.

Although most of the gold districts in southern Nova Scotia have been described as located on anticlinal fold hinges (Malcolm, 1929), this investigation clearly demonstrates that most of the auriferous zones are located on the steepest limb of asymmetric fold structures (Table 1). However, it is noted that a few deposits actually do occur in fold hinges with the most notable examples being the Caribou, Tangier and Mooseland districts. Best mineralization is commonly associated with minor folds on the limbs of major folds.

At many of the deposits similar **litholigical packages** host the vein-type mineralization (Fig. 3). The most diagnostic host rock is a black, sulphide-rich pelite. Thinly banded, multicoloured siltstone or semipelites is also a characteristic host rock at several deposits (e.g. Fifteen Mile Stream, Beaver Dam, Goldenville). Although similar lithologies appear to be common in most gold districts, they do not represent a unique stratigraphic horizon, but instead may represent 1-4 km long discontinuous stratigraphic lenses throughout the Meguma Group. One such horizon was postulated by McBride (1978) for southeastern Nova Scotia although he believed that it was a unique horizon. The approximate stratigraphic positions of various lithologies for several Au and Au-W deposits relative to the Goldenville/Halifax transition zone are indicated in Figure 3. Identification and geological mapping of these stratigraphic packages may be one of the best exploration mechanisms for delineating and following the mineralized zones. The sulphide-rich nature of some of these auriferous units (e.g. Beaver Dam) offers the potential of excellent geophysical targets.

The foregoing discussion suggests that modifications regarding the traditional genetic models applied to the Nova Scotia 'saddle reef' gold deposits are required. Our preliminary observations illustrate that the complexity of quartz veins, both texturally and mineralogically, is not accommodated by any single model. Indeed it requires, if not demands, that several stages of vein formation spanning syn-to post-tectonic conditions be permitted. The presence of extremely large alteration halos (i.e. measuring x km^2) record the passage of substantial volumes of fluid and indicate that the fluid dynamics of these systems are not solely confined to the vein structures. Thus, a model is required which accounts for the channelling of large fluid volumes through specific stratigraphic or structural sites which results in the formation of alteration halos. It is also suggested that the presence of local thermal highs, as recorded by the presence of anomalous metamorphic mineral assemblages, is a critical element in the formation of auriferous deposits. Together with the alteration haloes this serves as a viable exploration target easily mapped in the field. Finally, the presence of certain key lithologic units in some areas emphasizes the importance of detailed stratigraphic study, especially where such units host the ore horizon and have a good geophysical response.

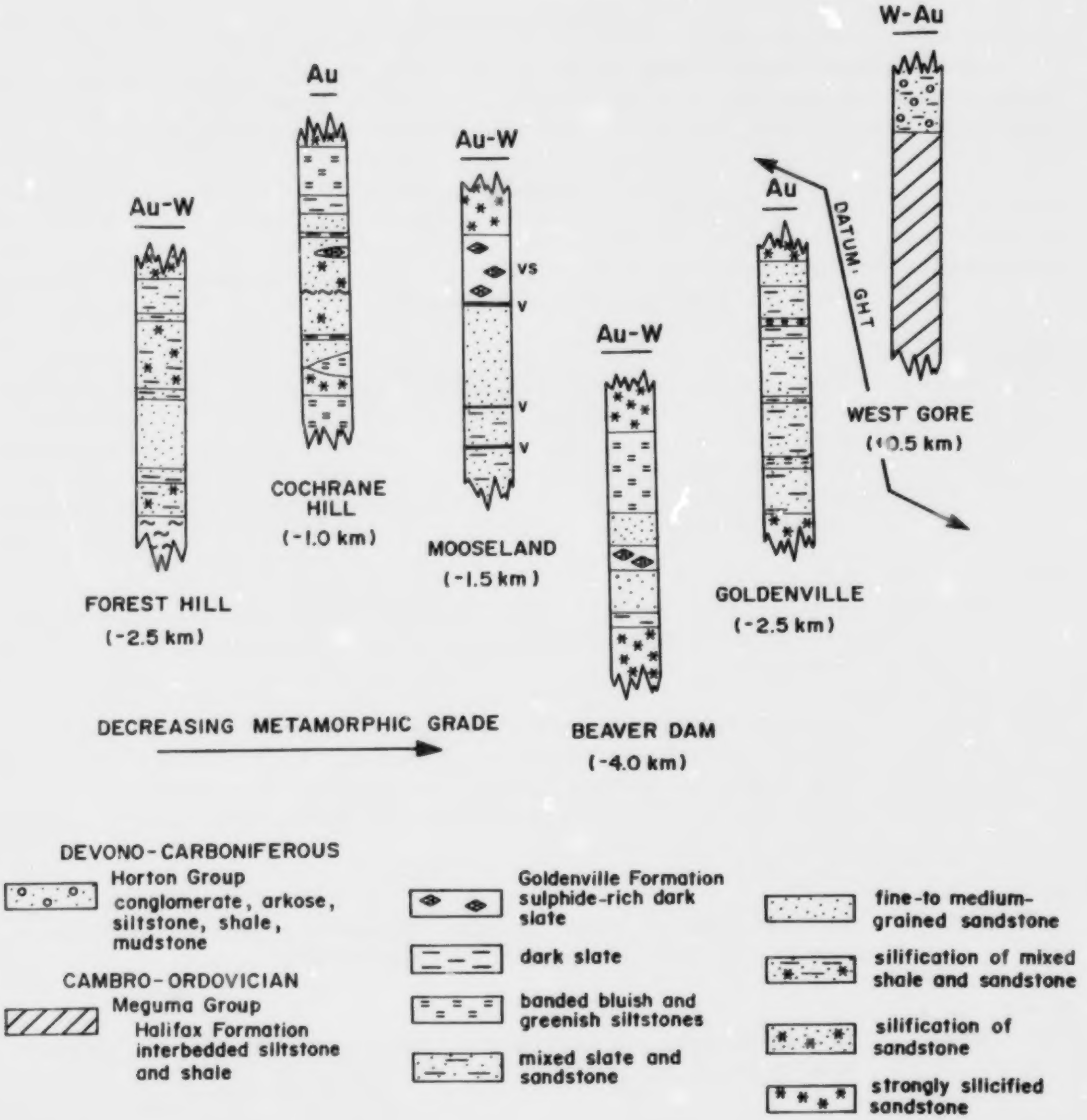
Au-W
FOREST HILL
(-2.5 km)
Au
COCHRANE HILL
(-1.0 km)
Au-W
VS
V
V
V
MOOSELAND
(-1.5 km)
Au-W
BEAVER DAM
(-4.0 km)
Au
GOLDENVILLE
(-2.5 km)
DATUM, GHT
W-Au
WEST GORE
(+0.5 km)
DECREASING METAMORPHIC GRADE
DEVONO-CARBONIFEROUS
Horton Group conglomerate, arkose, siltstone, shale, mudstone
CAMBRO-ORDOVICIAN
Meguma Group
Halifax Formation interbedded siltstone and shale
Goldenville Formation sulphide-rich dark slate
dark slate
banded bluish and greenish siltstones
mixed slate and sandstone
fine-to medium-grained sandstone
silification of mixed shale and sandstone
silification of sandstone
strongly silicified sandstone

Figure 3. Generalized lithological sections of host rocks at several gold districts in the Eastern Meguma Terrane. The positions of the sections are indicated in kilometres beneath the Goldenville-Halifax Transition (GHT) zone.

ACKNOWLEDGMENTS

The authors acknowledge the co-operation, enthusiatic support and unrestricted access to the properties and unpublished data of Seabright Resources Incorporated and Novacan Mining Resources (1985) Limited.

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BASE METAL PROJECT*

J. M. Patterson

The first full year of the Base Metal Project concentrated on three of the deposits identified in 1985 for study (i.e. Walton, Yava and Eastville (Fig. 1).

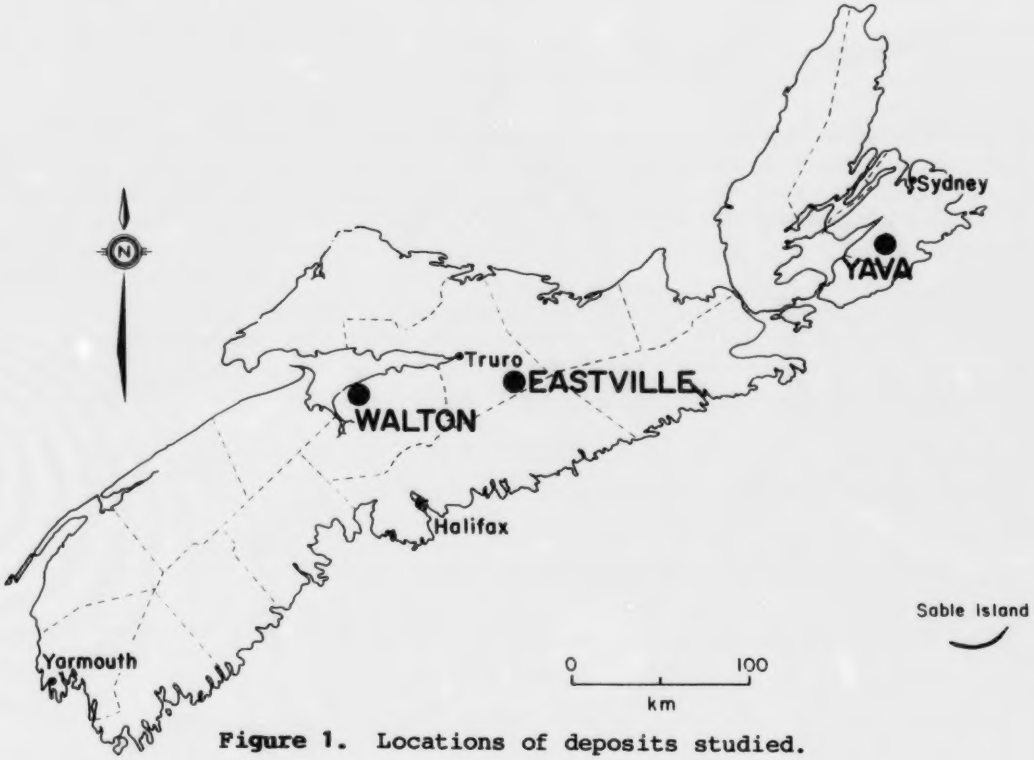

Figure 1. Locations of deposits studied.

WALTON MINE
(Ba,Pb,Cu,Zn,Ag)

The high silver content (approximately 12 oz/t of sulphide ore milled) marked Walton as an important deposit for study. Geological and assay data from all 656 underground and 136 surface drillholes have been entered into a personal computer and programs developed to manipulate the data (Burns and Patterson, 1986).

The aims of this study are to assess the current information on the deposit, and to identify the exploration potential both in the immediate vicinity of the deposit and also along the important Horton Group/Windsor Group contact. Figure 2, a composite cross-section, shows that the deposit remains open below the lowest mine level at 1650 ft. Though the orebody

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*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

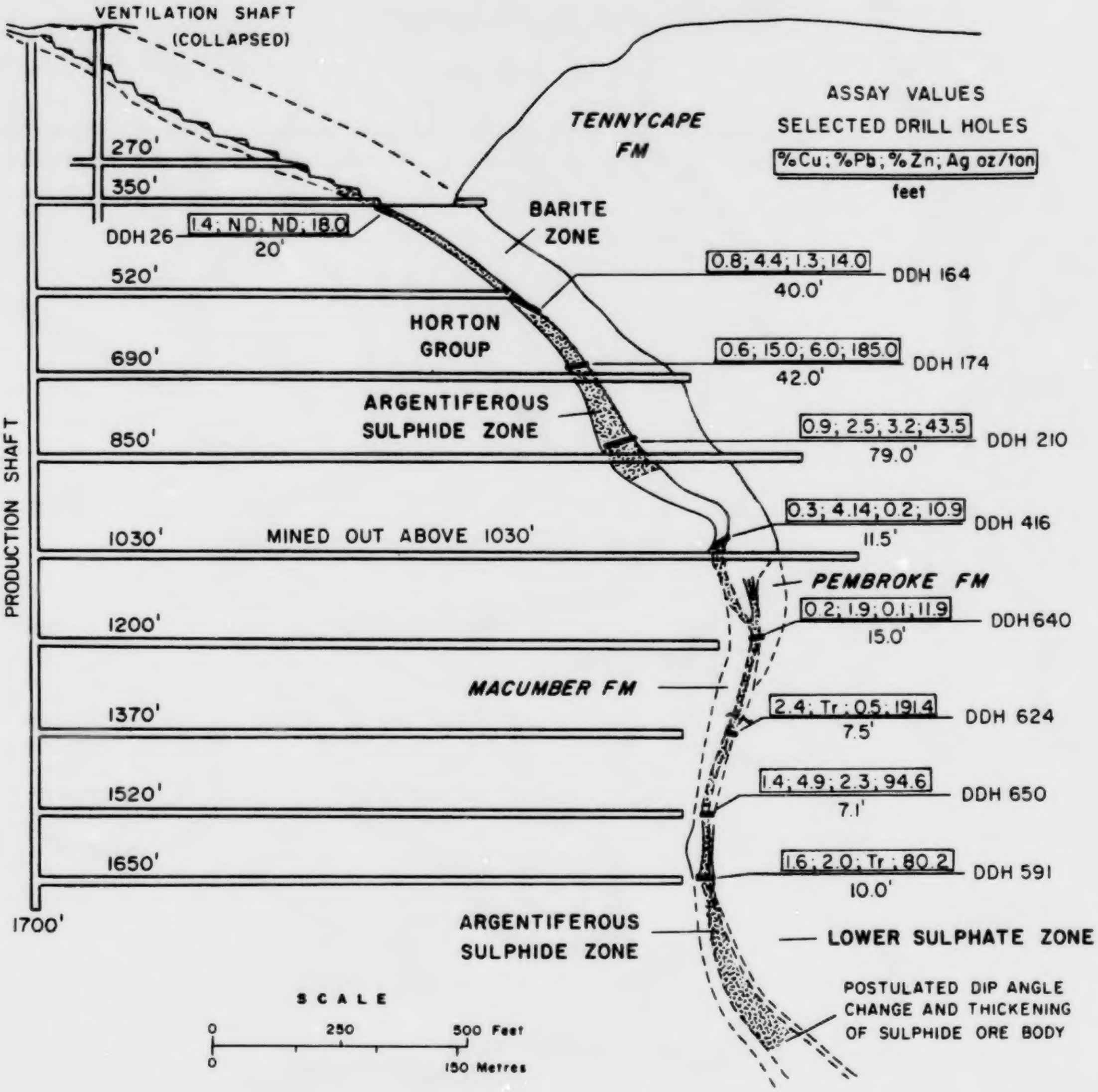
VENTILATION SHAFT (COLLAPSED)
TENNYCAPE FM
ASSAY VALUES
SELECTED DRILL HOLES
%Cu; %Pb; %Zn; Ag oz/ton
feet
270'
350'
DDH 26
1.4; ND; ND; 18.0
20'
BARITE ZONE
520'
0.8; 4.4; 1.3; 14.0
40.0'
DDH 164
HORTON GROUP
690'
0.6; 15.0; 6.0; 185.0
42.0'
DDH 174
ARGENTIFEROUS SULPHIDE ZONE
850'
0.9; 2.5; 3.2; 43.5
79.0'
DDH 210
PRODUCTION SHAFT
1030'
MINED OUT ABOVE 1030'
0.3; 4.14; 0.2; 10.9
11.5'
DDH 416
PEMBROKE FM
1200'
0.2; 1.9; 0.1; 11.9
15.0'
DDH 640
MACUMBER FM
1370'
2.4; Tr; 0.5; 191.4
7.5'
DDH 624
1520'
1.4; 4.9; 2.3; 94.6
7.1'
DDH 650
1650'
1.6; 2.0; Tr; 80.2
10.0'
DDH 591
1700'
ARGENTIFEROUS SULPHIDE ZONE
LOWER SULPHATE ZONE
POSTULATED DIP ANGLE CHANGE AND THICKENING OF SULPHIDE ORE BODY
SCALE
0
250
500 Feet
0
150 Metres

Figure 2. Cross-section of the Walton deposit.

has been mined out to the 1030 Level, a drillhole from the 1650 Level intersected 29 ft at 30.0 oz silver/t, including a 10 ft section assaying 80.2 oz silver.

During exploitation of the deposit approximately 360,000 tons of sulphide ore were milled with an average millhead grade of 0.7% Cu, 5.0%Pb, 1.7% Zn and 12.0 oz/t Ag. At today's metal prices this converts to a gross metal value of US$125 (CND$174) per ton. Silver contributes approximately 58% of the value.

YAVA MINE
(Pb,(Zn))

This large tonnage/low grade former lead producer is now owned by the Province. As part of a program to more completely document the potential of the deposit, a shallow drilling program was undertaken in the spring of 1986. This program, aimed initially at delineating the western limits of the West Zone, involved the drilling of 12 vertical drillholes totalling 1888 ft.

A map showing total metal content (Fig. 3), outlines a relative enrichment in zinc in the central part of the drilled area. This zinc-enriched area supports an analogy with the large Laisvall deposit in

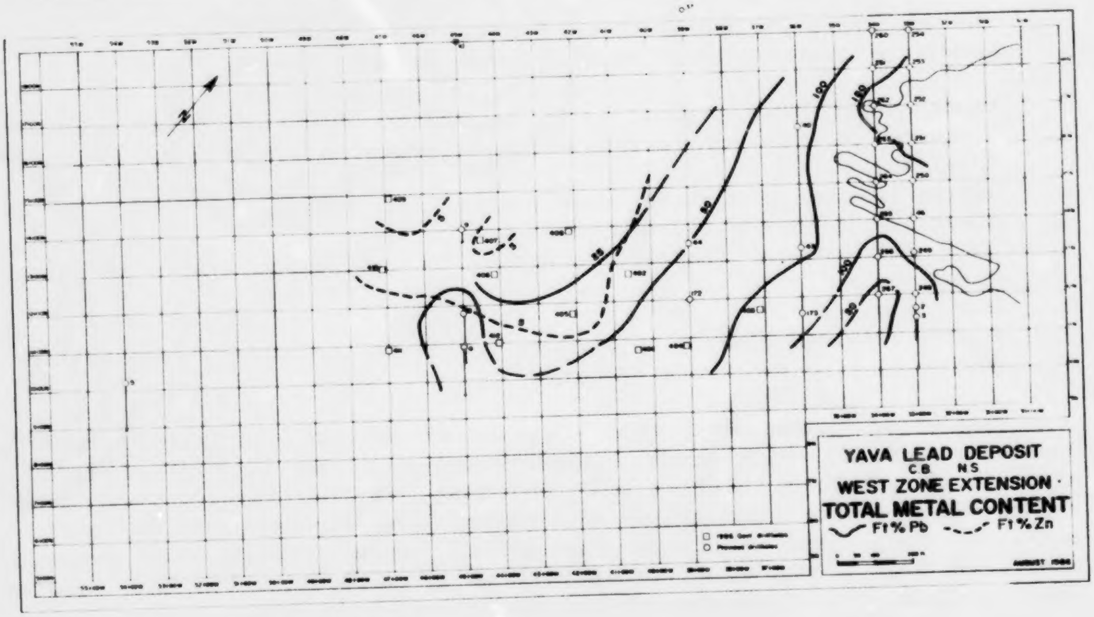

Figure 3. Yava lead deposit, West Zone extension: total metal content.

northern Sweden, where a blind zinc orebody was discovered down dip and at a higher stratigraphic level than the lead orebody which was the object of the original mine development (Rickard et al., 1979).

Further support for the possibilites of zinc mineralization at the Yava deposit is an intersection cut at approximately 800 ft above the Pennsylvanian/Windsor Group contact, in a hole drilled to the north and west of the recent drill area by US Borax in 1980. This hole intersected 3.32% Pb, 2.26% Zn and 1.09 oz Ag/t over 2 ft in a coaly horizon.

This intersection, together with the results of the recent drill program, justify a continuing investigation of the zinc potential of the Yava deposit.

EASTVILLE DEPOSIT
(Pb, Zn)

This important Meguma Group hosted Pb-Zn mineral deposit was investigated in an attempt to describe the styles of mineralization present and to quantify their contribution to total grade. The pilot study, undertaken by T. M. Stokes, a Dalhousie post-graduate student, under contract, was confined to 6 holes in the West Grid of the 10 km long deposit.

The following styles of mineralization were identified and are listed in approximate chronological order (1 being oldest):

1. bedding sulphides; predominantly pyrrhotite; 70-80% of total sulphides
2. cleavage (transposed) sulphides; predominantly pyrrhotite; 10-20% of total sulphides
3. quartz tension gash veins; with remobilized pyrrhotite
4. other quartz veins; no sulphides
5. sphalerite-galena fracture breccia mineralization; 3-7% of total sulphides
6. calcite veins
7. pyrite veinlets closely related to sphalerite fracture mineralization
8. pyrite-bearing stockwork breccias

The study confirmed a good correlation between sphalerite fracture mineralization and high grade lead-zinc values. Two sets of sphalerite mineralized fractures bearing 065° and 355° are confirmed. Lower grade values occur where sphalerite and galena are disseminated in bedding parallel foliations and in zones of minor sphalerite fracture mineralization. The main concentrations of mineralization are located where the two sets of sphalerite-bearing fractures intersect.

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REGIONAL GEOCHEMICAL SURVEYS*

R. F. Mills, P. A. Lombard and P. J. Rogers

INTRODUCTION

A regional geochemical stream sediment survey covering the northern half of the Province was initiated in May 1986 and will continue into the next field season. The work is a joint project within the Canada-Nova Scotia Mineral Development Agreement.

The main objective of the project is to provide heavy mineral stream sediment and water data at the regional scale for the provincial geochemical atlas. Information from this survey will be processed with geochemical information from the rest of the Province.

Heavy minerals from stream sediments and stream water samples are being collected as part of a regional survey covering the northern half of the Province. (Fig. 1). Approximately 1300 localities have been sampled during the 1986 field season.

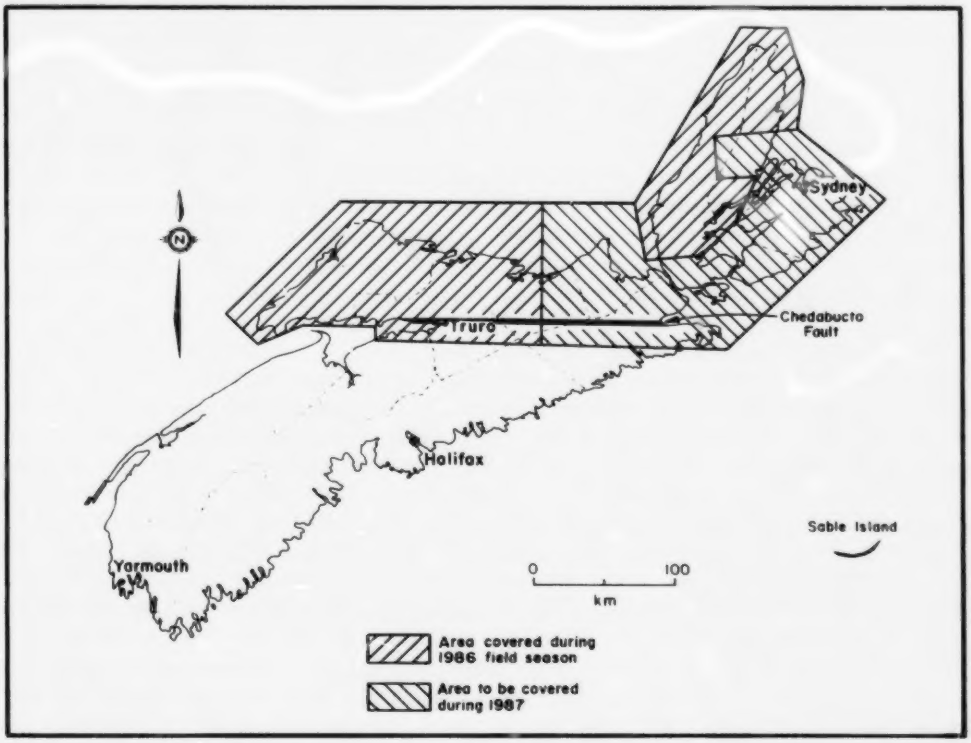
N
Sydney
Chedabucto Fault
Truro
Halifax
Sable Island
Yarmouth
0
100
km
Area covered during 1986 field season
Area to be covered during 1987

Figure 1. Fieldwork covered in 1986 geochemical stream sediment survey.

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*Funded by Geological Society of Canada and Nova Scotia Department of Mines and Energy under the Canada Nova Scotia Mineral Development Agreement

Coverage of these areas is done by fly camping on foot to inland localities that are inaccessible by helicopters. A complete coverage as possible is important as these areas usually lie along major fault zones (i.e. the Aspy River Gorge).

SAMPLING TECHNIQUE

It is quite probable that fine gold can be carried off by water surface tension (Boyle 1979). In the field sampling procedure, the loss of fine gold is minimized by preventing water loss which also protects the sample from contamination. A -18 mesh sample is sieved on site. Sieves consist of wooden housings bolted together with nylon bolts which, in turn, support nylon mesh. The sample drops into a plastic pan along with all water used to sieve the sample. The sample and all water are collected and transported in a 3 ml gauge polythene bag from which all air is removed before sealing. The sample stands for several days before decanting by siphoning. It is assumed that the fine gold will settle out in the sample and not be lost. Workers have, in the past, attempted to minimize fine gold loss by settling and the use of flocculating agents. This new technique developed at Nova Scotia Department of Mines and Energy is not known to have been used elsewhere.

ANALYTICAL PROCEDURE

Quality control procedures are followed using the Geological Survey of Canada sample format. Samples are organized into analytical batches of twenty samples. Each batch contains one sample which has a field duplicate in the batch. One sample is split after preparation as the analytical duplicate and a standard is randomly placed within each batch. The format is designed for simplicity and ease when applying statistical tests and review of the fractions analyzed.

The stream waters will be analyzed for U by fluorimetry and F by specific ion electrode. Conductivity and pH levels will also be determined. Heavy liquid separation will be performed on the - 60 +230 fraction of the stream sediments. The -230 fraction will be collected by wet sieving. Magnetic minerals will be removed prior to analysis from the -60 +230 mesh fraction by hand magnet. The -60 +230 (non-magnetic) fraction will be analyzed for Au, As, Sb, Ba, Cd, Cs, Cr, Co, Eu, Hf, Ir, Fe, La, Mo, Ni, Rb, Sc, Se, Ag, Ta, Tb, Th, W, U, Yb, Zn by INAA, and Sn and Ti by XRF. The - 230 fraction will be analyzed for Au by INAA and Li, Rb, Ba, Na, K, Al, Ag, Cd, Co, Cu, Mn, Fe, Ni, Zn, V and Bi by ICP-AES.

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SOUTH MOUNTAIN BATHOLITH PROJECT PLEISTOCENE MAPPING*

R. M. Graves and P. W. Finck

INTRODUCTION

Mapping and sampling surficial deposits overlying the granitic terrain of southwestern Nova Scotia continued during 1986. The purpose of this survey is to: (1) study the glacial geology, (2) conduct a regional till geochemical survey, and (3) attempt to fit the South Mountain Batholith till stratigraphy into a regional framework that has been described by previous workers.

The area studied encompasses map sheets 21A/09, 21A/10, 21A/15 and 21A/16. Approximately 700 till samples were collected for geochemical analysis. The pebble fraction was separated from the till for further examination. Emphasis is being placed on identifying and correlating the granitic pebbles with the local bedrock geology. Heavy minerals from the -50 +230 mesh fraction of 5 kg till samples are being analyzed for Au, Sn, W, Nb and Ta. The -230 fraction is being analyzed by XRF for trace elements at Saint Marys University and also at Bondar Clegg using the "gold +25" analytical package.

DESCRIPTION OF TILLS IN STUDY AREA

WATERLOO LAKE

The large number and the variability of deposits make this area (Fig. 1) particularly interesting. Granitic regolith, 2 m thick, is commonly found in section and is seen overlying bedrock with striations trending 125°. The regolith has the textural appearance of a granite but crumbles into disaggregated grains when dug by a shovel. Till wedges containing non-granitic clasts dip generally eastward in the regolith. This may imply ice thrusting from the west. Two km southeast of Waterloo Lake a 2 m cut of compact granite till, containing approximately 25% foreign clasts, is exposed in a gravel pit. This till is coeval or younger than the till wedges in the regolith.

The mud facies of the Lawrencetown Till is also found in the same general area. The presence of basalt, mafic intrusives and felsic tuff show that a large proportion of the Lawrencetown Till was derived from north of the South Mountain Batholith. Fine grained purple quartzites were noted in clast counts from the till. Smitheringale (1973) identified a pink to purple quartzite member belonging to the White Rock Formation. It is located 50 km north of this area of Lawrencetown Till.

A stony, local granite till sheet of varying thickness is common in the Waterloo Lake area. Clast content may vary from 100% pink biotite granite to 100% fine grained two-mica monzogranite.

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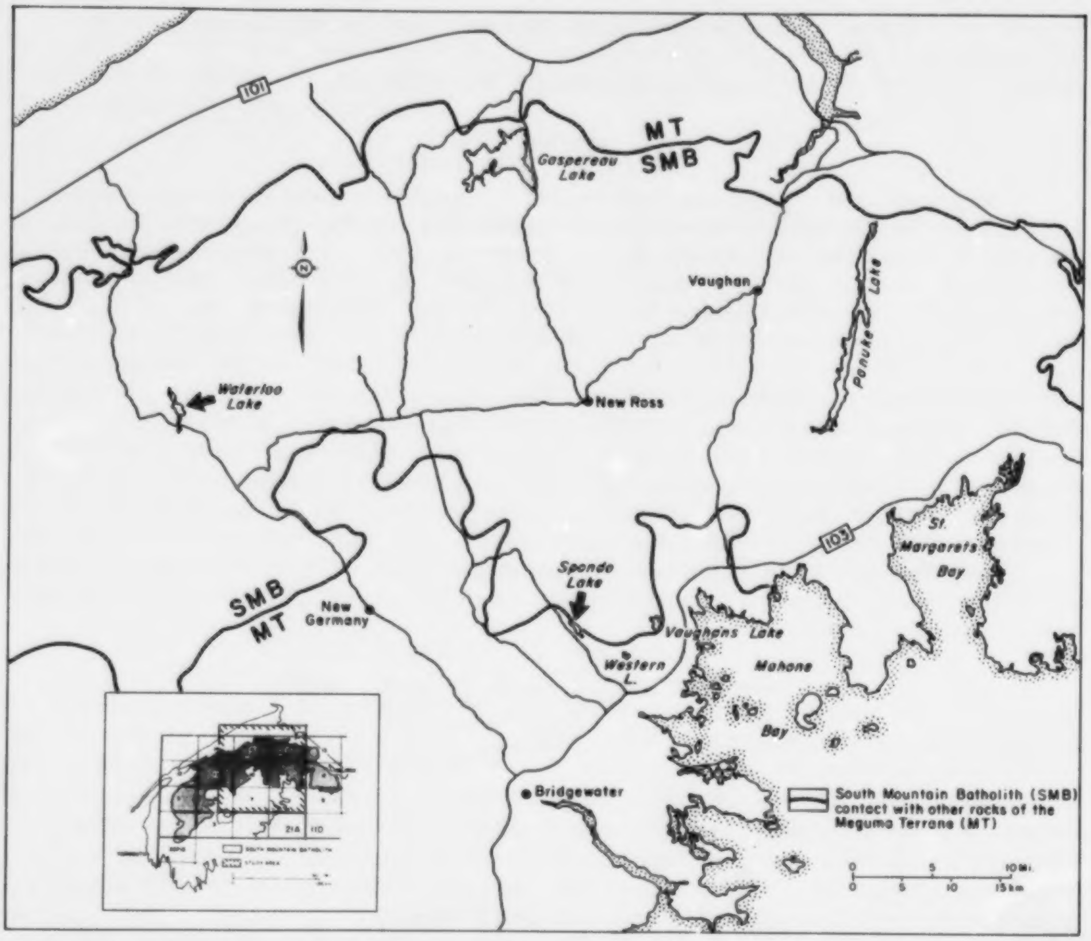
101
MT
SMB
Gaspereau Lake
Vaughan
Panuke Lake
N
Waterloo Lake
New Ross
St. Margarets Bay
103
Spondo Lake
SMB
MT
New Germany
Vaughans Lake
Western L.
Mahone Bay
Bridgewater
21A
11D
South Mountain Batholith (SMB) contact with other rocks of the Meguma Terrane (MT)
0 5 10 Mi.
0 5 10 15 km

Figure 1. Location map indicating study area with respect to South Mountain Batholith.

Ice contact stratified drift is found 2 km south of Waterloo Lake at Stoddart West Meadows. It occurs as low mounds of interlayered coarse sands and gravels. Clasts are approximately 50% subangular to subrounded biotite granite and fine grained two-mica monzogranite with 50% rounded foreign clasts. The high concentration of foreign clasts may be due to derivation from locally occurring Lawrencetown Till.

SPONDO LAKE

This area is of interest due to the local nature of the till. A general east to west trending contact between biotite monzogranite and Meguma Group rocks extends from Vaughans Lake to Spondo Lake. North of this contact the till is mapped as loose, stony granite till with a sandy matrix while south of the contact the till is a loose, stony greywacke to slate till. The north to south transition from biotite monzogranite till to a greywacke-slate till is rapid. Along a bush road north of Western Lake, the change occurs over 10 m, oriented perpendicular to the bedrock contact. A similar relationship was observed at Zwickers Stillwaters and at the south end of Spondo Lake.

The stony till in the Spondo Lake area is laterally extensive and forms a texturally distinct unit that can be subdivided on the basis of clast geology. It is felt that till is local and reliable as an indicator of underlying bedrock geology.

CONCLUSION

The Waterloo and Spondo Lake areas only partially illustrate the diversity and the complex inter-relationships of surficial deposits overlying the South Mountain Batholith that have been studied to date. It is expected that further subdivision of the surface tills is possible on the basis of lithology, texture and transport distance.

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1973: Geology of parts of Digby, Bridgewater and Gaspereau Lake map-areas; Geological Survey of Canada, Memoir 375, 78p.

DATING OF THE FIVE ISLANDS FORMATION, NOVA SCOTIA, AND THE DEGLACIATION OF THE BAY OF FUNDY*

*R. R. Stea and D. M. Wightman***

ABSTRACT

Three atomic mass spectrometry (AMS) dates have been obtained on shell material from the bottomset beds of a glaciomarine delta at Spencers Island, Nova Scotia. The sediments in the delta are part of the previously undated Five Islands Formation, a lithostratigraphic unit that encompasses glaciofluvial, glaciolacustrine and glaciomarine deposits laid down during the retreat of the glaciers and the rise and fall of sea level. The dates range from 14,300 years B.P. to 12,600 years B.P. These dates may record the difference in age between initial deglaciation in the Minas Basin and delta formation after the ice had retreated to the land masses.

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*Funded by Geological Survey of Canada under the Canada - Nova Scotia Mineral Development Agreement

**Alberta Research Council, P.O. Box 8330 Station F, Edmonton, Alberta T6H 5X2

THE GARDEN OF EDEN DISPERSAL TRAIN*

R. G. Turner and R. R. Stea

INTRODUCTION

This study is part of the surficial mapping program carried out under the Canada-Nova Scotia Mineral Development Agreement. Garden of Eden is located on the southern edge of the Antigonish Highlands, adjacent to the St. Marys Graben in Pictou County, Nova Scotia. It is an ideal location to study glacial dispersal because of its unique geological history. The Eden Lake Complex is a Late Precambrian rock suite composed of appinite, hornblende syenite, pegmatite and microgranite (J. B. Murphy, personal communication, 1986). The appinite clasts are dispersed from isolated stocks of the Eden Lake Complex. These clasts are very distinctive and easily recognized in the background of sedimentary and felsic volcanic rocks. Striations in this area record four major ice flow events (Fig. 1). The purpose of this study is to determine the net effect of glacial dispersal during these four ice flow events.

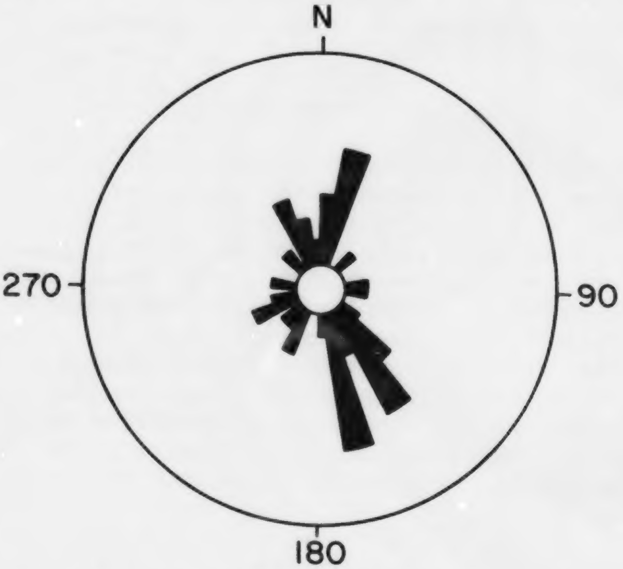

Figure 1. Plot of all striations measured in the map area for which ice flow is known.

The majority of previous glacial dispersal studies in Nova Scotia have been conducted in the Meguma Terrane south of the present study area and deal with the dispersal of tin, tungsten and gold in till. The dispersal patterns of mineralized debris from their source deposits are southward and

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*Funded by Geological Survey of Canada and Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

southeastward trending unidirectional or lobate fans (Prest, 1911; Wilson and Richardson, 1980; DiLabio, 1982; MacEachern and Stea, 1985; Turner, 1986).

A Late Wisconsinan (Scotian) ice divide extends across the axis of southern Nova Scotia on the Meguma Terrane (Grant, 1977; Stea and Finck, 1984). Little movement occurs in an ice sheet near an ice divide (Denton and Hughes, 1981). The Meguma Terrane exhibits little geomorphological evidence of the existence of this ice divide. Erosional (striations) and depositional (till, erratic boulders) evidence of ice movement attributed to the Scotian ice divide, however, is found in northern Nova Scotia (Stea and Finck, 1984). Dispersal studies done in Nova Scotia north of the Meguma Terrane have determined the effect of northward flow from the Scotian ice divide (Bailey, 1898; Hickox, 1962).

Stea and Finck (1984) also postulated an ice centre in the Antigonish Highland region east of the Garden of Eden based on the distribution of striations and erratic boulder dispersal. This centre of flow developed after the Scotian ice divide. The Garden of Eden is uniquely situated to study the effects of glacial dispersal because of its position north of the Scotian ice divide and west of the proposed Antigonish Highland centre of flow.

METHODOLOGY

Quantitative data to determine the effect of glacial dispersal in the Garden of Eden area was collected from three sources: (1) fence boulder piles in farm fields, (2) lag boulders washed out of till sections, and (3) pebble counts from previously collected till samples. In each case between 150 and 200 boulders or pebbles were counted and the percent of appinite clasts determined. A total of 51 boulder piles and till lag sites were counted. Till sample pebble counts were only used where either boulder piles or lag sites were absent. The percentage of appinite clasts is generally lower in the till samples. These samples represent a much smaller sampling area and are occasionaly taken from basal tills that are rich in local debris. The fence boulder piles provided the most accurate counting method as the lichen covering disguised the stones and eliminated bias.

DISCUSSION

Four major ice flows have traversed the Garden of Eden. The relative ages of these ice flows have been recorded at two striation sites near Eden Lake. A summary of these flows from oldest to youngest is 1) N140E, 2) N165E, 3) N005E and 4) N220E.

Figure 2 shows the dispersal pattern of appinite erratics from the Eden Lake area. The dispersal pattern is summarized in Table 1.

The 1-5% contour of appinite erratics indicates a four-directional trend similar to the striation directions. The long southeast (140°-160°) and south-southeast (170°-180°) dispersal lobes are clearly the dominant patterns. The latter may be the result of a slight directional shift in the major southeast Wisconsinan ice flow that occurred throughout Nova

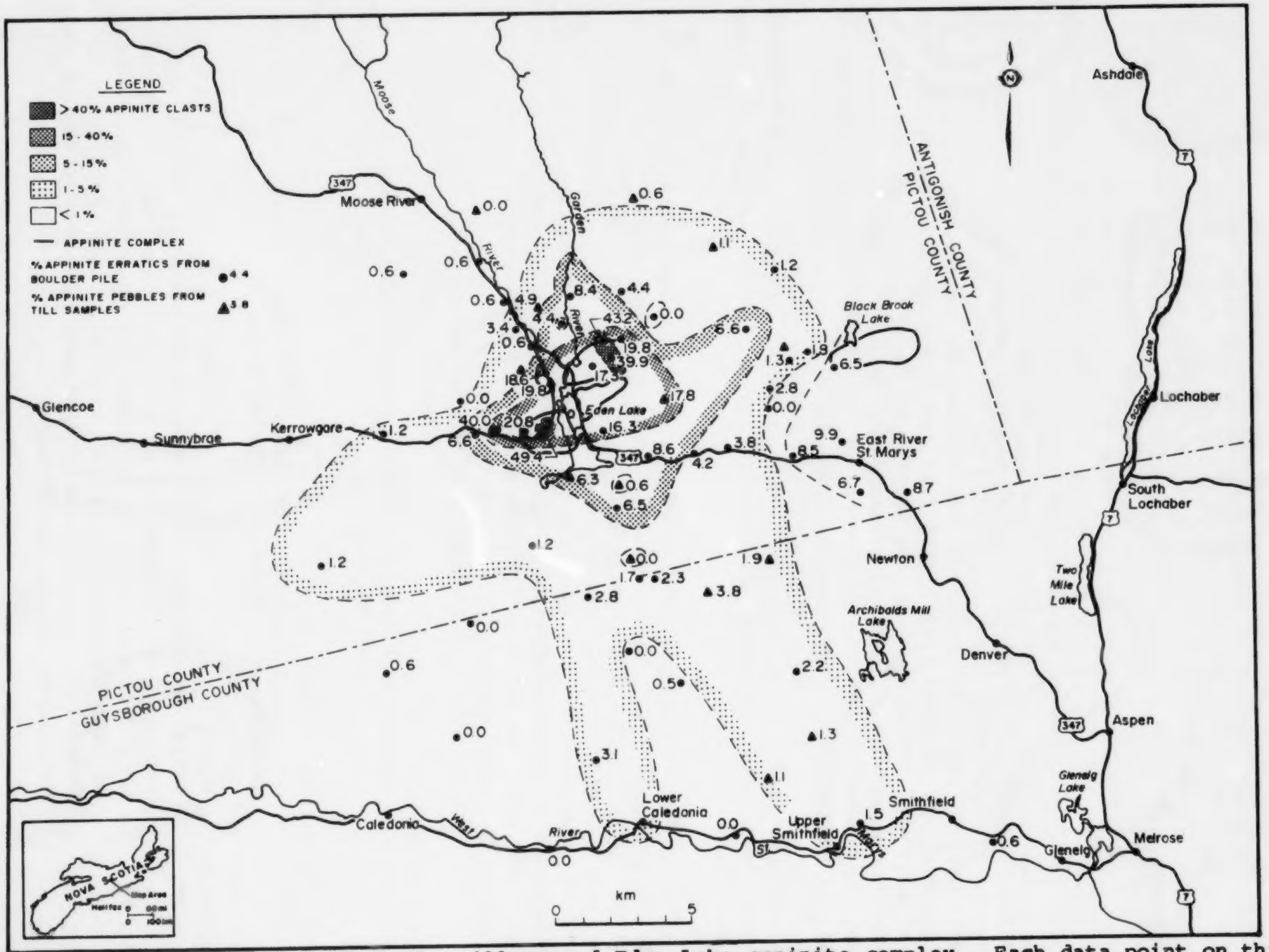
LEGEND
>40% APPINITE CLASTS
15 - 40%
5 - 15%
1 - 5%
< 1%
APPINITE COMPLEX
% APPINITE ERRATICS FROM BOULDER PILE ● 4 4
% APPINITE PEBBLES FROM TILL SAMPLES ▲ 3 8
N
ANTIGONISH COUNTY
PICTOU COUNTY
PICTOU COUNTY
GUYSBOROUGH COUNTY
Moose River
Moose
River
347
Garden
River
Eden Lake
Black Brook Lake
East River St. Marys
Glencoe
Sunnybrae
Kerrowgare
Newton
Archibalds Mill Lake
Denver
Aspen
Ashdale
Lochaber
Lochaber Lake
South Lochaber
7
Two Mile Lake
Glenelg Lake
Glenelg
Melrose
Caledonia
West
River
St.
Marys
Lower Caledonia
Upper Smithfield
Smithfield
0.0
0.6
0.6
0.6
4.9
8.4
4.4
0.0
1.1
1.2
3.4
4.4
43.2
0.6
19.8
39.9
17.3
6.6
1.3
1.9
6.5
18.6
19.8
17.8
2.8
0.0
0.0
40.0
20.8
16.3
9.9
6.6
1.2
49.4
8.6
4.2
3.8
8.5
6.3
0.6
6.5
6.7
8.7
1.2
1.2
0.0
1.9
1.7
2.3
2.8
3.8
0.0
0.0
2.2
0.6
0.5
0.0
1.3
3.1
1.1
0.0
0.0
1.5
0.6
km
0
5
NOVA SCOTIA
Map Area
Halifax
0 60mi
0 100km

Figure 1. Dispersal patterns in the till around Eden Lake appinite complex. Each data point on this contour map of appinite erratics represents % appinite clasts in 150-200 stone count.

Table 1. Dispersal characteristics

Azimuth	% Appinite	Extent (km)	Shape
140-160	1-5	-	lobe
	5-15	5	lobe
170-180	1-5	15-20	lobe
080-350	1-5	7-8	broad fan
	5-15	4-5	lobe
225-250	1-5	10	broad fan
	5-15	2	lobe

Scotia. The maximum extent of the 140°-160° trending dispersal lobe is not known as it intersects with dispersal from the appinite complex near Black Brook Lake. Appinite boulders are dispersed northwest to northeast (350°-080°) and southwest (225°-250°) of the Eden Lake Complex in the form of broad fans. These fans correspond to the known ice flows recorded in striation measurements. The broad northward dispersal fan is a result of changes in flow during the northward ice movement. Northward striations measured over the map sheet area form two distinct groups between 330°-350° and 0°-20° (Fig. 1). The southwestward trending striations measured over the map area range from 200°-250°. The magnitude and the extent of the southwestward and northward dispersal fans is small compared to the southeastward lobes.

The 15-40% contour of appinite clasts surrounds the Eden Lake Complex and has only 0.5 to 2 km of onlap on the adjacent rocks. Two areas, located directly over the Eden Lake Complex with no apparent dispersal, have >40% appinite clasts. These areas are thought to be coincident with zones of appinite in the Eden Lake Complex. A third area with >40% appinite clasts is located about 1 km west of the mapped complex. It may suggest the presence of another unmapped appinite complex.

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SURFICIAL GEOLOGY/GEOCHEMISTRY DATABASE*

A. A. Cotie and R. R. Stea

INTRODUCTION

Surficial geology, geochemical and lithological databases have been compiled for about 2000 till samples taken in mainland Nova Scotia from 1977 to 1985 (Fig. 1) (Stea and Fowler, 1979; Stea and O'Reilly, 1982; Stea et al., 1986).

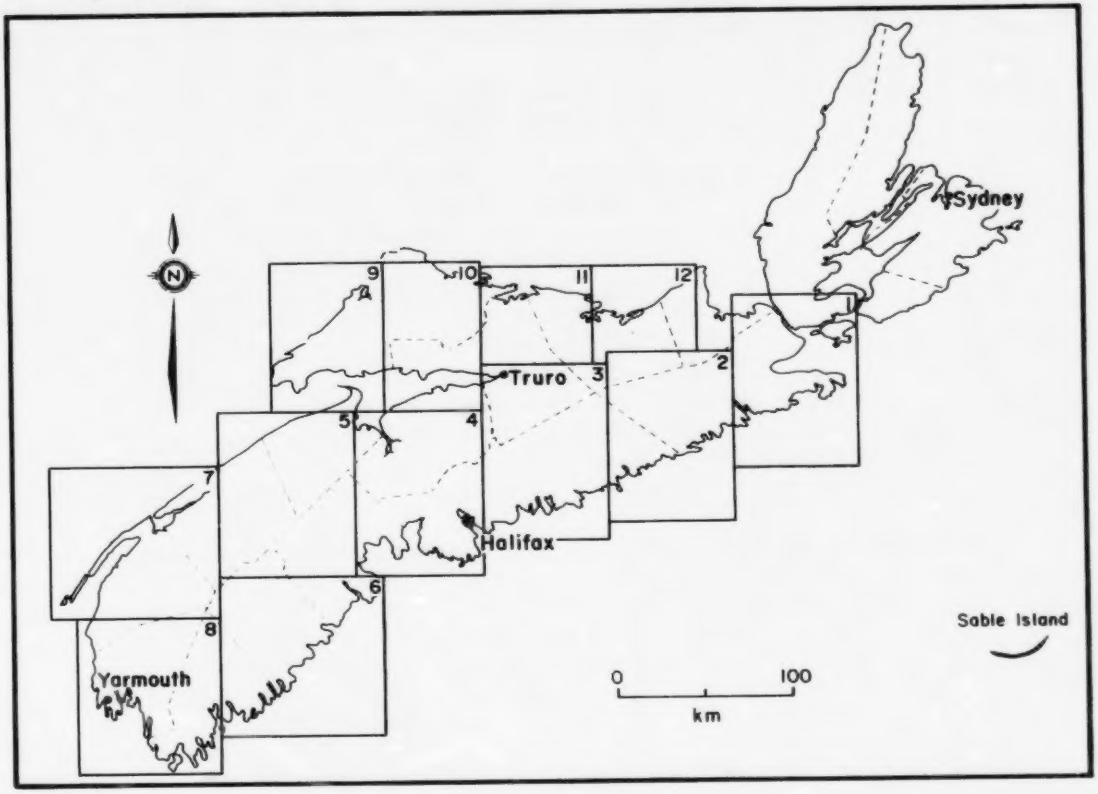

Figure 1. Index map of 1:100 000 map sheets.

This data is on 5 1/4" floppy disks and was compiled using the database management system DBASE III+. A menu driven program has been designed which allows a person with little computer experience to access and view the data (Figs. 2 and 3).

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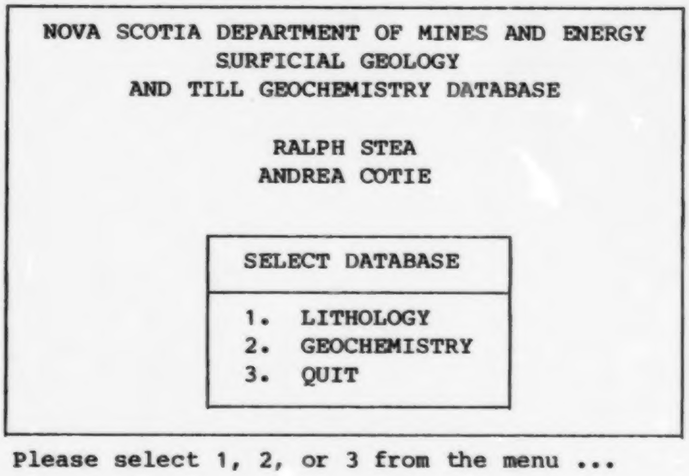
*Funded by Nova Scotia Department of Mines and Energy and Geological Survey of Canada under the Canada - Nova Scotia Mineral Development Agreement

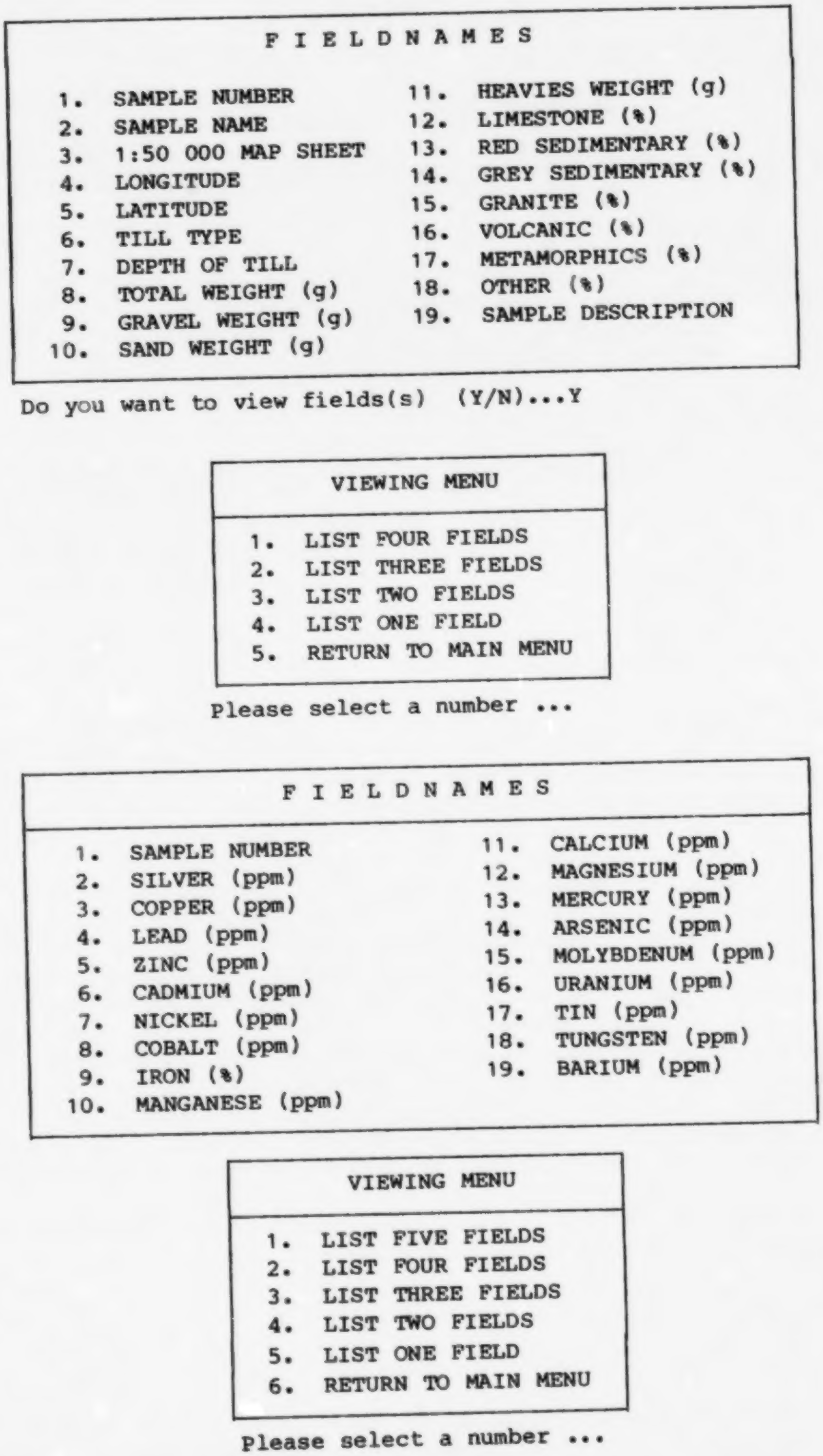
The program allows the user to choose the database from which he/she would like to view fields, i.e. lithology or geochemistry. The user is then guided through the program with error checking and the option to exit the program from certain menus. The user may choose up to five fields from the database which are then displayed to the screen. A hard copy of the data can also be obtained with a print option.



```
NOVA SCOTIA DEPARTMENT OF MINES AND ENERGY
SURFICIAL GEOLOGY
AND TILL GEOCHEMISTRY DATABASE

RALPH STEA
ANDREA COTIE

SELECT DATABASE

1.  LITHOLOGY
2.  GEOCHEMISTRY
3.  QUIT

Please select 1, 2, or 3 from the menu ...
```

Figure 2. Main Menu

A more detailed description of the database will be available at the Open House.



```
                       F I E L D N A M E S

   1.  SAMPLE NUMBER              11.  HEAVIES WEIGHT (g)
   2.  SAMPLE NAME                12.  LIMESTONE (%)
   3.  1:50 000 MAP SHEET         13.  RED SEDIMENTARY (%)
   4.  LONGITUDE                  14.  GREY SEDIMENTARY (%)
   5.  LATITUDE                   15.  GRANITE (%)
   6.  TILL TYPE                  16.  VOLCANIC (%)
   7.  DEPTH OF TILL              17.  METAMORPHICS (%)
   8.  TOTAL WEIGHT (g)           18.  OTHER (%)
   9.  GRAVEL WEIGHT (g)          19.  SAMPLE DESCRIPTION
  10.  SAND WEIGHT (g)

Do you want to view fields(s)  (Y/N)...Y
```

```
        VIEWING MENU

  1.  LIST FOUR FIELDS
  2.  LIST THREE FIELDS
  3.  LIST TWO FIELDS
  4.  LIST ONE FIELD
  5.  RETURN TO MAIN MENU

Please select a number ...
```

```
                       F I E L D N A M E S

   1.  SAMPLE NUMBER              11.  CALCIUM (ppm)
   2.  SILVER (ppm)               12.  MAGNESIUM (ppm)
   3.  COPPER (ppm)               13.  MERCURY (ppm)
   4.  LEAD (ppm)                 14.  ARSENIC (ppm)
   5.  ZINC (ppm)                 15.  MOLYBDENUM (ppm)
   6.  CADMIUM (ppm)              16.  URANIUM (ppm)
   7.  NICKEL (ppm)               17.  TIN (ppm)
   8.  COBALT (ppm)               18.  TUNGSTEN (ppm)
   9.  IRON (%)                   19.  BARIUM (ppm)
  10.  MANGANESE (ppm)
```

```
        VIEWING MENU

  1.  LIST FIVE FIELDS
  2.  LIST FOUR FIELDS
  3.  LIST THREE FIELDS
  4.  LIST TWO FIELDS
  5.  LIST ONE FIELD
  6.  RETURN TO MAIN MENU

Please select a number ...
```

Figure 3. Fieldnames and viewing menus for the lithology and geochemistry databases.

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MICROCOMPUTER BASED DATABASE APPLICATIONS FOR MINERAL EXPLORATION AND MINING*

I. G. Burns and J. N. Patterson

Drillhole location, assay and geological information from the Walton mine have been compiled over the past several months in a microcomputer based format.

Using the programming language in dBASE III+, an application has been created to provide a menu-driven database management system. This system which offers record management facilities (addition, deletion, editing and retrieval of records) has been expanded to do the following:

1. display and update current prices for base and precious metals,
2. display all intersections in a given drillhole,
3. calculate the dollar value of a given metal at a selected intersection and the dollar values of all metals at a given intersection, and
4. display the relative contribution of the different metals as a percentage of the total value.

Facilities have also been included to calculate the total dollar value of any drillhole. By expressing the cut-off in dollar terms, the user may quickly identify holes of commercial interest. In addition, the cut-off value may be varied and the viability of incremental intersections can be examined by varying the tolerance of the cut-off value.

Results are displayed on the monitor, allowing the geologist to select the start and end points from which a hardcopy report, showing the individual assay values and the weighted average assay over the length chosen, may be produced. The same techniques have been applied to data from the Yava mine and similar approaches will be used for the Stirling deposit.

The application program is of modular design, allowing individual modules to be used in other programs where applicable. It has been prepared using the IBM version of dBASE III+ and will run on an IBM PC or true compatible having at least 328K of RAM and dual 360K floppy drives. There will be demonstrations of the system at various times during Open House.

The routines developed will facilitate access to information which is useful to those involved in the exploration for and assessment of ore bodies.

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*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

SUMMARY OF NOVA SCOTIA DEPARTMENT OF MINES AND ENERGY LONG RANGE SYSTEM PLAN 1986-91*

P. J. Rogers and D. W. Rigby

On December 5, 1985, Tony Brown of Coopers and Lybrand Consulting Group (CLCG) presented his report on computing needs within the Nova Scotia Department of Mines and Energy (NSDME). It was concluded that the ability of staff to meet the objectives of the Department is being seriously hampered by the lack of convenient and timely access to electronic data processing facilities (EDP), including both word and data processing.

Alternative EDP strategies were presented in terms of three additive phases: *Phase One* is the purchase of IBM compatible micro-computers to be used within individual divisions of the Nova Scotia Department of Mines and Energy. *Phase Two* is the purchase and installation of a central mini-computer. Several of the Phase One micro-computers will be linked to the central mini-computer for data access and enquiry purposes. *Phase Three* is the purchase of suitable cartographic hardware and spatial analysis software to analyze and plot geological data. The cost benefit analysis indicates substantial savings will be made following the installation of computer equipment.

In 1985-86, 12 micro-computers with peripherals and software (workstations) plus 2 back up tape units were purchased. This represents about 50% completion of Phase I.

The acquisition of micro-based systems and associated software has greatly increased the number of stand-alone computer systems in the Department. All of these systems are in use and available to most Department members on demand as personal and project-oriented productivity aids. Most computers are supporting multi-task users including word processing, database and spreadsheet analysis. Present developments for these systems includes a number of turn-key applications purpose written in DBaseIII + by summer programming staff. Most of these applications are for database uses for specific tasks, the Claims Registry System being a good example. All micro-based systems are maintained by systems operators, usually permanent Departmental staff who are responsible for the daily operation of the systems and security of the hard disk drives. Computer usage is monitored and detailed logs kept by systems operators for their machines.

Expertise and knowledge gained about computer applications are shared through regular meetings of various departmental user groups. In-house training seminars are held on demand to assist in disseminating information on the use and application of micro-based computer technology. The continuing need for exposing as many departmental staff to computers is a major component of the on-going training and information strategy. The decision making structure at NSDME is contained in a task related set of computer committees which have been developed to implement the current LRSP on a day to day basis, and to re-evaluate and update it annually, Figure 1 gives details of the NSDME structure.

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*Funded by Nova Scotia Department of Mines and Energy under the Canada - Nova Scotia Mineral Development Agreement

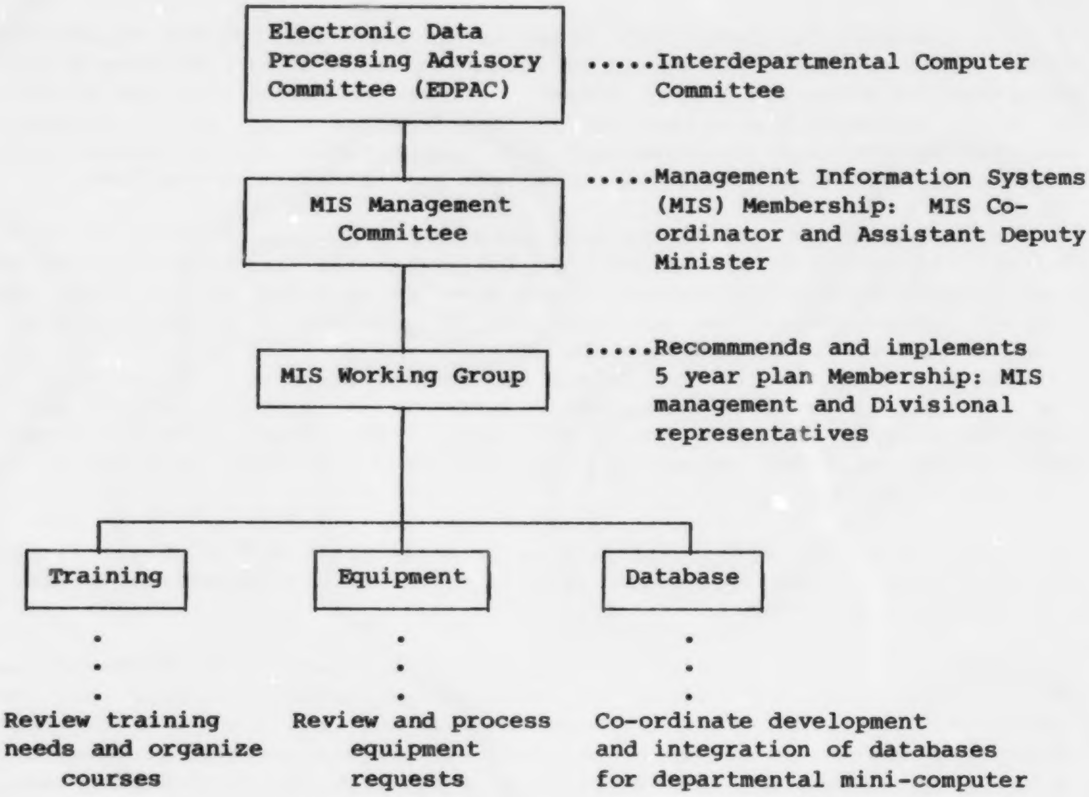
Electronic Data Processing Advisory Committee (EDPAC)
.....Interdepartmental Computer Committee
MIS Management Committee
.....Management Information Systems (MIS) Membership: MIS Co-ordinator and Assistant Deputy Minister
MIS Working Group
.....Recommmends and implements 5 year plan Membership: MIS management and Divisional representatives
Training
Equipment
Database
Review training needs and organize courses
Review and process equipment requests
Co-ordinate development and integration of databases for departmental mini-computer

Figure 1. Computer-related committees

It is proposed in 1986-87 to largely complete Phase One by the purchase of an additional 10 micro work stations and to prepare for the purchase of the central mini-computer.

The prime objective and justification for a new mini-computer is to repatriate revelant portions of external databases which need to be shared within the Department and beyond. They are presently widely dispersed and the repatriation and consolidation will allow much wider use and dissemination of information via a truly Department-wide database. The central mini-computer will play a crucial role in networking of data, word processing, data management, plotting of maps and electronic mail. The cost savings and benefits for the support of in-house facilities due to this repatriation and consolidation of data is one of the principal justifications for the purchase of the mini-computer system.

The preparation of a request for proposal, installation and system testing for a mini will probably take anywhere from 6 to 12 months. It is of the utmost importance that the process be inititated and expedited in the 1986-87 fiscal year to maintain the momentum of integration of these databases. However, of equal importance, if not greater than hardware acquisition, is the correct selection of appropriate database software systems. The most likely form of database systems for the Department's mini-computer is one which can handle attribute (data) and spatial (mapping) analysis, in other words, the Geographic Information System (GIS) originally Phase Three. Essentially Phases Two and Three are combined due to the growing realization that a combined GIS/database package will satisfy all of the Department's database needs. In order to expedite this selection, the hiring of a person with GIS experience is given priority as the first step in design of the Department's database. This post would be full-time and provide the resources needed to co-ordinate the collection, selection and design of database structure. The experience and knowledge gained by this person would be invaluable and a natural precursor to the creation of a System/Database manager. Table 1 indicates that $20,000 needs to be allocated to this task to cover salaries and benefits for the last 6 months of the 1986-87 fiscal year (October 1986 to March 1987).

WORD PROCESSING AND COMMUNICATION BETWEEN WORD PROCESSING SYSTEMS

The objective is to develop a system in which text can be transferred between scientific and word processing workstations without modification. The challenge is to achieve this in a way that does not jeopardize the speed, functionality and printing quality equal to that of the present in-place Micom system.

At the present time, data and text for memos, letters, reports and publications are entered through a variety of machines and software which includes electric typewriters, Micom word processors and micros with Word Perfect version 4.1 software. Text previously entered on an electric typewriter is the least transferable since it must be rekeyed entirely in any of the other systems. Next comes text entered through a Micom system. A Micom 2000 to micro Word Perfect transfer system has been developed in the Mineral Resources Division which can transfer standard text and tables between these two word processing systems. The process strips off control characters including bolding, underlining, etc. which must be rekeyed after transfer. The process also requires the preparation of files for transfer which involves extra time. If there is a long term commitment to the Micom word processing system, there is a transfer system available commercially which will allow Micom to micro Word Perfect transfer without modification or file preparation.

Text is also being entered through the scientific micros with Word Perfect. These are compatible between each other without modification. The Mineral Development Division has acquired a micro with Word Perfect as a word processing workstation and is continuing to explore the functionality of the software for various word processing tasks. The requirements of the publications section of the Mineral Resources Division is both intensive and exacting. The staff in the Mineral Resources Division are undertaking an intensive testing of the Word Perfect software to see if it can be tailored to provide the speed and functionality required.

Table 1. NSDME 5 Year Plan Computer Requirements: Data and Word Processing

LOCATION	86/87	87/88	88/89	89/90	90/91	Total
Department	Sdev @20	Mini @30 Sdev @80 Dcon @15 Minf @10 Mink @10 GISDB @30	Mini @30 Sdev @80 Dcon @30 Mten @ 5 GISDB @30	Mini @30 Sdev @80 Mten @ 5 GISDB @30	Mini @30 Sdev @80 Mten @ 5 GISDB @30	
Subtotal (x$1000)	20	175	175	145	145	660
DIVISION						
Administration	WP/DB		XT			
Cartography	SlideA/plot modem		PLOT @5	PLOT @5	PLOT @5	
Energy Management	AT XTport(4)					
Energy Resources						
Mining Engineering						
Mineral Development	AT(3)/XT plot					
Mineral Resources	AT/Wprc plot	Wprc	Wprc	Wprc		
Subtotal (x$1000)	110	10	25	15	5	165
Total (x$1000)	130	185	200	160	150	825

Mini = Mini computer workstation 5yr lease/purchase
Sdev = System development analyst/operator; 2 man/yr @ $40,000
Dcon = Data conversion; summer student @ $15,000 man/yr
Minf = Mini installation furniture
Mten = Mini maintenance contract/year
Mink = Mini linkage to 10 PC-ATs with hot key @ $1,000
PLOT = 36" plotter; 3yr lease/purchase
plot = 11 by 17" desk plotter @ $3,000
AT/XT = average workstation with printer & software @10,000
Wprc = word processing workstation @ $10,000
GISDB = combined spatial analyis and database software eg.ARC/INFO

The publications section also requires high quality printing of long documents with wide column tables. Investigation will be undertaken in 1986 of a laser printer which can be switched between a micro and a Micom in order to produce manuscripts which are close to typesetting quality.

Given the incompatibility among existing word processors in the Department, it is important that any word processing package purchased for the mini, should be compatible with the Word Perfect software or include an efficient and easy-to-use transfer program.

EDUCATION AND PUBLIC AWARENESS*

H. V. Donohoe and M. E. Devanney

The purpose of the Education and Public Awareness Program (EPAP) of the Mines and Minerals Branch is to develop educational information about the geology, mineral resources and mining history of the Province. The Canada-Nova Scotia Mineral Development Agreement (CNSMDA) plays an important role in the operation of the Program. Under the CNSMDA, the EPAP and the Public Information Program (PIP) share the objectives of building a broader understanding of mineral commodities, mining exploration, geology and mineral resources in Nova Scotia and of the government's role in promoting and managing them. These objectives are achieved through the publication of informative booklets, brochures and newsletters, travelling exhibits, a very popular series of guided walks, and the preparation and display of audio-visual packages.

A series of general information brochures now available include *Nova Scotia Gold, Minerals and Mining in Nova Scotia* and *The Geology of the Halifax-Dartmouth Area*. Brochures in the advanced stages of production are *Coal in Nova Scotia* and *The Rock and Mineral Collecting Guide to Nova Scotia*. In addition, a number of pamphlets dealing with regulatory issues have been produced, namely *Mineral Rights, Landowners, and Mineral Exploration and Information on Staking Claims in Nova Scotia*. The *Directory of Goods and Services for Exploration Companies* provides a convenient reference to companies serving Nova Scotia's exploration industry. Several longer publications near completion include *Gold in Nova Scotia*, and *Geology, Minerals and Mining in Nova Scotia*.

Again this summer, groups have been guided on a walking tour of the building stones in downtown Halifax. The walk highlights the building stones and their constituent rocks and minerals as well as providing an insight into the historical development of the Province's building stone industry. The continued popularity of the building stone walk prompted the development of a guided walk to study the geology and landforms of Point Pleasant Park. This walk emphasizes how geological history influenced the settlement of Halifax. These co-operative projects, initiated by the Department and the Nova Scotia Museum, are funded under the CNSMDA.

Other collaborative NSDME - NS Museum projects include joint publications and the development of a mining loan kit available for use in the education system. The mining kit will include samples of rocks and minerals of economic importance, videos and an information package including brochures, posters, pictures and a teachers resource guide. The video presentations will depict a cross-section of commodities and mining methods representing different geographic regions of the Province. Preparation of these 'rock videos' began this fall with the filming of the underground salt mine at Pugwash, Cumberland County and the open-pit tin mine at East Kemptville, Yarmouth County. As well the Nova Scotia

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*Funded by Nova Scotia Department of Mines and Energy and the Canada - Nova Scotia Mineral Development Agreement

Department of Mines and Energy and the Nova Scotia Museum, with assistance from the Mining Society of Nova Scotia, Chamber of Mineral Resources, Department of Education and teachers are preparing an economic loan kit. This kit will complement the optional mining unit that is offered at the junior high school level. Targeting it at grade 8 students will allow some overlap of both elementary and high school usage.

The EPAP maintained a busy display schedule during the summer erecting displays in locations throughout the Province (Table 1). These included a number of mall exhibits where displays could be introduced to a representive section of the general public.

Table 1. Summer display schedule-1986

Dates	Location	Event
May 30, 31	Truro	K-Mart Mall display
June 13, 14, 15	Windsor	Nova Scotia Forestry Exhibition
June 20, 21	Sydney	Mayflower Mall display
June 25, 26, 27, 28	Ingonish	Mining Society of Nova Scotia
July 4, 5	Halifax	Halifax Shopping Centre display
July 25, 26	New Glasgow	Aberdeen Mall display
August 8, 9, 10	Parrsboro	Rockhound Roundup
August 23, 24	Yarmouth	K-Mart Plaza display
September 5, 6	Bridgewater	Bridgewater Mall display
September 13, 14	Waverley	Waverley Gold Rush Days

The typical display format highlights the geology and mining industry of Nova Scotia and material related to the activities and programs of the CNSMDA. Samples of rocks and minerals native to the Province, including those of economic importance, are a popular part of the display, as are the giveaway samples accompanied by descriptions. Where applicable, displays include material of local interest. In Sydney, the importance of coal was highlighted, while in Yarmouth, a poster on tin generated a great deal of interest. The focus of the display at the Rockhound Roundup in Parrsboro centred on some of the more interesting rock and mineral localities in the area, and the recent fossil-find. The gold panning demonstration at the Waverley Gold Rush Days was a great success. Personnel were available to answer questions and identify samples at all displays.

The course *Prospecting in Nova Scotia* continues to be popular. Twenty-two people enrolled in the 1986 spring session at Dalhousie University, which was sponsored by the Nova Scotia Department of Mines and Energy, the Chamber of Mineral Resources of Nova Scotia and the Department of Geology at Dalhousie. An advanced prospecting course is in the planning stages.

With the support of the Public Information Program of the CNSMDA, projects are planned to prepare filmstrip presentations outlining the geology, mining and mineral resources of the Province, a continuing photographic record of exploration and mining developments, photographic packages related to the mining history of the Province, video documentaries on the geological history and mineral resources of Atlantic Canada, and newsletters. The intent of these projects is to reveal aspects of geology and mining normally seen and understood only by professionals.

ACADIA UNIVERSITY
DEPARTMENT OF GEOLOGY RESEARCH

*J. A. Colwell**

Acadia University is located in Wolfville, Nova Scotia, in the eastern Annapolis Valley about 100 km northwest of Halifax. The geology department consists of 7 full-time professors, 2 part-time lecturers and 1 demonstrator. There are 54 undergraduate majors and 10 graduate students.

The geology department emphasizes an integrated field and laboratory approach and offers instruction and research training leading to the Bachelor of Science, Bachelor of Science with Honours and Master of Science degrees. Our undergraduate degree programs have been revised and both are four year degrees. Research funding mainly comes from faculty grants and contracts which are held by most of our staff. All of our fulltime graduate students also hold fellowships.

Research conducted by the faculty and students is diversified. However, our main thrust is Nova Scotian geology with various projects involving economic geology, igneous petrology, metamorphic petrology, geochemistry, biostratigraphy, paleontology, sedimentology, ichnology, structural geology, regional geology and basin analysis.

RESEARCH PROJECTS

S. M. Barr - Continued regional mapping programs in Cape Breton Island and southern New Brunswick; Related petrologic studies emphasize granitoid and volcanic units.

B. W. Cameron - Barrier island development; lithostratigraphy and age of the Scots Bay and Blomidon Formations based on conchostracans and newly discovered silicified snails, ostracodes and fossil fresh water algae.

J. A. Colwell - Mineral deposits; clay mineralogy; geology of the North Mountain Basalt; zeolites.

R. G. Moore - Biostratigraphy of the Windsor Group; geologic mapping in the Mosherville, Rawdon and Clarksville areas.

R. P. Raeside - Regional mapping of the Cape Breton Highlands; metamorphism of the Meguma Group, southwestern Nova Scotia.

G. R. Stevens - Structural geology, southwestern Nova Scotia; rock fabric; remote sensing and computer graphics.

N. A. Van Wagoner - Physical volcanology of the Fourchu Group, Cape Breton Island, in order to determine the paleovolcanic setting of these rocks.

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*Head, Department of Geology, Acadia University, Wolfville, Nova Scotia

M.Sc. THESES IN PROGRESS

L. Daigle - Sedimentology of the Lower Stellarton Units, Pictou County, Nova Scotia.

F. Dennis - The Deep Cove Granite and associated Cu-Mo-Ag-Bi mineralization, southeastern Cape Breton Island.

T. Hope - Contact metamorphism of the Port Mouton Pluton, southwest Queens and southeast Shelburne Counties, Nova Scotia.

M. Justino - Geology of the Marble Mountain area, Cape Breton Island.

R. Snow - Sedimentology and depositional environment of the Thorburn Member of the Stellarton Group in Nova Scotia.

M. Thicke - The East Bay and Coxheath volcanic belts, Cape Breton Island.

W. Yaowanoiyothin - Petrology of the Black Brook Pluton and associated gneisses, Cape Breton Highlands.

B.Sc. THESES IN PROGRESS

M. Bromley - Geology of the melange at Clarke Head, Nova Scotia.

B. Eddy - Structure and metamorphism of the White Head Village area, Guysborough County, Nova Scotia.

G. Howells - Lithostratigraphy of a drill core from the Riverside Corner area, Hants County, Nova Scotia (G. Howells).

A. Steele - Petrology and geochemistry of samples from Gabbronorite I Subzone of the Stillwater Complex, Montana.

THE MINERAL TECHNOLOGY PROGRAM
UNIVERSITY COLLEGE OF CAPE BRETON
SYDNEY, NOVA SCOTIA

INTRODUCTION

The Mineral Technology program was established in 1968 as part of the Nova Scotia Eastern Institute of Technology, a forerunner of the present University College of Cape Breton, and graduated its first class in 1970. Since then 123 students have obtained their diplomas and may be found employed throughout Canada in all aspects of the mining and petroleum industries. Many of the earlier graduates now occupy senior technical and management positions. Figures on initial employment within three months of graduation show 20% of the graduates are employed in exploration, 20% in production, 17% in processing, 10% in other related employment (sales and service industries) and 10% in unrelated employment. Some 10% have continued university studies while 10% are unemployed for three months or longer.

OBJECTIVES

The curriculum objectives of the program reflect the employment distribution. It is designed to provide a strong fundamental background for technical employment in the exploration, production and processing phases of the mineral industry. The course spans 2 years or 20 months (2400 hours) with the student graduating as a Mineral Technologist (Dipl. T.). In addition, geology is taught to civil, environmental and chemical technology students, computer programming to chemical technology students, and environmental technology and surveying to enviromental technology students. Plans for future development include the addition of another 2 years to provide a Bachelor of Technology degree (B. Tech.) and adopting the co-op mode for the diploma program. A mining geology degree is also being investigated in co-operation with another university geology department.

Integrated field work and industry visitation are fundamental components of the program. Three-dimensional visualization, analytical problem solving and use of computers are stressed. Several courses are project oriented, leading to a final report. These include exploration methods and a mine feasibility study. In addition to visiting local mineral industry operations, one week in October of the second year is devoted to visiting mining operations in other areas of the Province and New Brunswick.

An industry advisory committee, meeting twice a year, serves to keep the program up-to-date. The committee comprises 16 senior personnel representing industry, government and educational institutions throughout Nova Scotia and New Brunswick.

MINERAL TECHNOLOGY CURRICULUM

TERM 1:		Theory hrs./wk.	Lab. hrs./wk.
59-011	Math I	3	
59-001	Communications I	2	
59-021	Physics I	2	3
59-031	Drafting I		3
54-001	Surveying I	2	3
50-051	General Chemistry	3	3
54-021	Geology I	3	3
		15	15

TERM 2:		Theory hrs./wk.	Lab. hrs./wk.
59-032	Drafting		3
59-012	Math II	3	
59-022	Physics II	2	3
59-002	Communications II	2	
59-042	Computer Programming		2
50-052	Chemistry II	3	3
54-032	Mining, Oil and Gas	2	
54-022	Geology II	3	3
		15	14

TERM 3:		Theory hrs./wk.	Lab. hrs./wk.
59-013	Math III	3	
54-003	Surveying II	2	3
54-023	Geology III	2	3
54-043	Mineral Processing I	2	3
54-053	Exploration Methods I	2	3
54-063	Surface Mining I	2	3
54-073	Underground Mining I	3	
54-083	Assaying I	1	3
		17	18

TERM 4:		Theory hrs./wk.	Lab. hrs./wk.
54-014	Math IV	3	
54-024	Geology IV	2	3
54-044	Mineral Processing II	2	3
54-054	Exploration Methods II	2	3
54-064	Surface Mining II	2	3
54-074	Underground Mining II	3	
54-084	Assaying II	1	3
		15	15

FACULTY

H. R. Oldale, B. Ed., M. Sc., P. Eng., the senior member, joined the Department in December 1967 to set up the program prior to it opening in September 1968. Before 1967 he had spent 10 years in geology, mine engineering, development and exploration management. He presently teaches geology and exploration methods.

H. E. Slaunwhite, B. Eng., B. Ed., P. Eng., a mining engineer, has taught in the program since 1969 after working 10 years in mining operations and industrial engineering throughout Canada. He presently teaches mineral processing, mining, computer programming and surveying.

F. M. Isenor, Dipl. T., B. Sc., a mining geologist, joined the Department in 1981. He is a former graduate of the Mineral Technology program and has had 7 years industry experience in exploration work and coal mining geology. His teaching responsibilities include geology, surveying and assaying.

C. P. Nicholson, Dipl. T., is a graduate of the Mineral Technology program. He joined the faculty in 1981 after 8 years experience in local mining and construction. His teaching duties include laboratory instruction in geology, mining, surveying, computers and exploration, in addition to laboratory maintenance and purchasing responsibilities.

REMOTE SENSING GEOLOGICAL INVESTIGATIONS
COLLEGE OF GEOGRAPHIC SCIENCES

M. S. Akhavi*

The College of Geographic Sciences, formerly known as the Nova Scotia Land Survey Institute, provides an opportunity for students enrolled in the Remote Sensing Program to undertake co-operative projects in their area of expertise with the assistance of an external agency. These projects are normally selected and defined by outside agencies. They involve 800 hours or more of student time, supervision and utilization of computing, image analysis, darkroom, cartographic and other facilities existing at the college. A member of the co-operating agency normally acts as external advisor and as a source of data. Therefore, these projects are of no direct cost to the external agency.

Table 1 is a list of 7 remote sensing, geological projects conducted under the author's supervision at the College of Geographic Sciences during the academic year 1985-86. The results of these investigations are compiled in the form of a final report containing geological maps, graphics, color slide enhancements of Landsat and other types of data. These reports are available at our library for public use.

The co-operative project is an integral part of the remote sensing training at the college. Proposals pertaining to the investigation of both renewable and non-renewable resources as well as environmental monitoring problems are welcome.

A number of our graduates are searching for employment opportunities, especially in the field of exploration geology utilizing remote sensing techniques. Arrangements can be made to send their addresses and phone numbers to prospective employers.

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*Senior Instructor, Remote Sensing Program, College of Geographic Sciences, Lawrencetown, Nova Scotia B0S 1M0

Table 1. Names, Academic Credentials, Co-Operative Projects and External Agencies

NAME	CO-OPERATIVE PROJECT TOPIC	EXTERNAL AGENCY
Donald Cameron B.Sc. Geology St. Francis Xavier University	A Geocoded Database Integrating LANDSAT and Airborne Radiometric Imagery for the Delineation of Mineral Occurrences in the Western Musquodoboit Area, Nova Scotia	GSC/EMR
Glenn Cameron B.Sc. Geology St. Mary's University	Hydrogeologic Investigations Utilizing Digitally Enhanced LANDSAT Data to Locate Shallow Groundwater Resources in the Vermillion, Alberta Region	Alberta Remote Sensing Centre Alberta Research Council
Linda Dobbin B.Sc. Geology Dalhousie University	Applications of Remote Sensing Techniques for the Detection of Vegetative Base Metal Mineralization Stress, Gays River, Nova Scotia	Kidd Creek Mines Limited
Terry Goodwin B.Sc. Geology Acadia University	Application of Remote Sensing Techniques for Mineral Exploration, Northwestern New Brunswick	Noranda Exploration Company Limited
Bruce Harmeson B.Sc. Geology Brock University	Integration of Landsat and Aeromagnetic Digital Imagery: Meguma Terrane, Guysborough County, Nova Scotia	GSC/EMR RADARSAT
William Jones B.Sc. Biology & Geology St. Francis Xavier University	Geological and Geobotanical Investigations of the Liscomb Pluton, Nova Scotia, Utilizing Remote Sensing Techniques	EMR/RADARSAT
Wayne McNeil B.Sc. Geology St. Francis Xavier University	Application of Airborne Digital Radiometric and LANDSAT Data for Discrimination of Igneous Phases and Mineral Exploration, Eastern Musquodoboit Batholith Area, Halifax County, Nova Scotia	GSC/EMR

ST. FRANCIS XAVIER UNIVERSITY
DEPARTMENT OF GEOLOGY

GENERAL

St. Francis Xavier University is located in Antigonish, about 250 km east of Halifax. The geology department consists of 6 staff members and approximately 50 undergraduate students.

The geology program is designed to provide a **strong fundamental background** for students who continue on to graduate study and at the same time to provide enough operational practical training to equip those who are immediately employed as professional geologists.

Our geology curriculum reflects this aim. Courses such as Mineralogy, Crystallography, Petrology, Stratigraphy and Sedimentation, and Structural Geology are specialized and basic. Applied courses include Ore Deposits, Petroleum Geology, Coal Geology, Geophysics and Geochemistry. The latter provide an opportunity to use and to elaborate on the basic principles encountered in earlier geology courses and courses obtained outside this department, especially physics, chemistry and mathematics. There is a seminar course for senior students that is directed to developing the students' capacity to formulate a problem, devise a plan of attack, execute the plan and report the results both orally and in written form. Figure 1 illustrates how the various courses are interwoven to form a coherent whole.

LABORATORY STUDIES

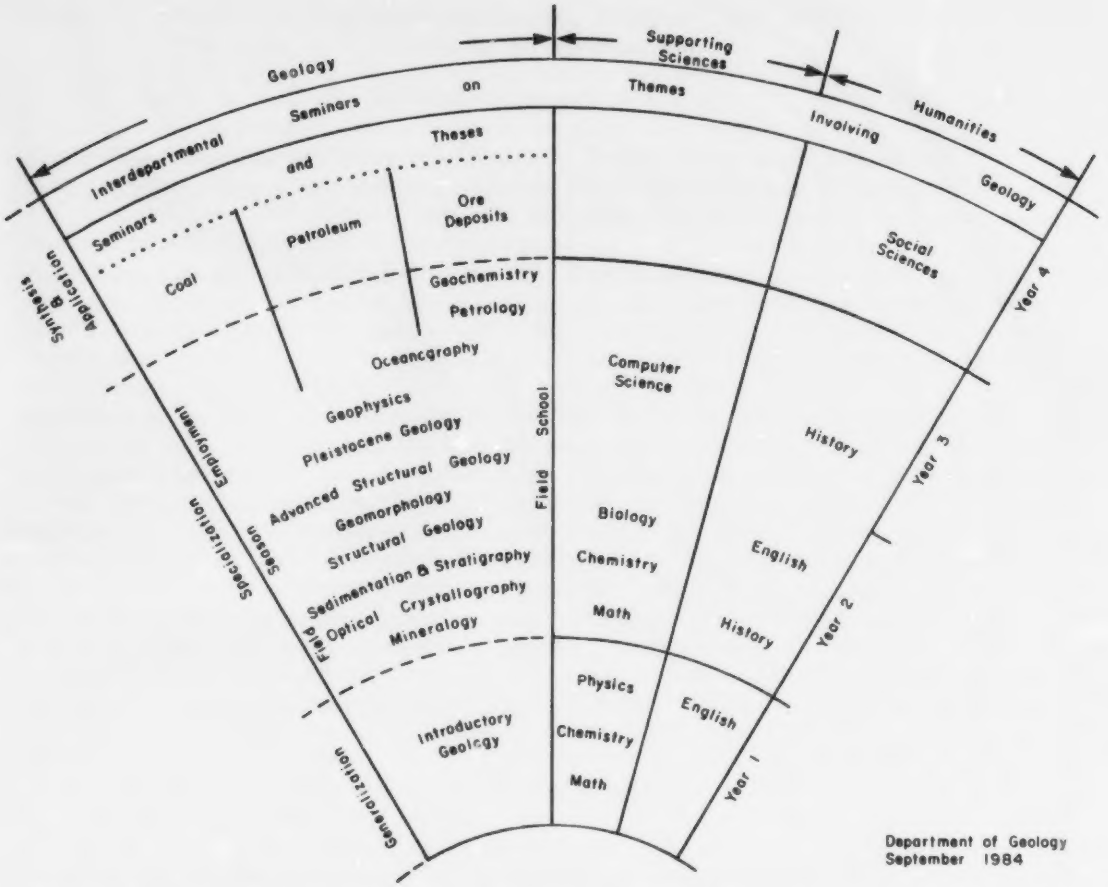
The field is viewed as the most important means of laboratory instruction. To bring together textbook and actual occurrence, certain laboratory periods are devoted to examination in the field. As expected, this is subject to seasonal restrictions.

In a number of branches of earth science, three-dimensional visualization is extremely important. In Mineralogy, training in three-dimensional visualization is promoted by the use of crystal models, lattice models and the examination of minerals in their actual crystalline form. In Structural Geology, three-dimensional training is continued through the use of descriptive geometry and stereographic projection.

Other aspects of laboratory work include the examination of thin sections under the petrographic microscope, analyses of structures on maps and geochemical analyses including work on radiometric dating of rocks.

FIELD CAMP AND SUMMER EMPLOYMENT

At the end of the sophomore year all students are strongly urged to attend the 10 day spring field camp held annually at St. Francis Xavier. The camp forms the core of a Field Methods course which also involves numerous mapping projects during sophomore, junior and senior years.


Geology
Supporting Sciences
Humanities
Interdepartmental Seminars on Themes Involving Geology
Seminars and Theses
Coal
Petroleum
Ore Deposits
Social Sciences
Geochemistry
Petrology
Oceanography
Computer Science
Geophysics
Pleistocene Geology
Advanced Structural Geology
Geomorphology
Structural Geology
Sedimentation & Stratigraphy
Optical Crystallography
Mineralogy
Biology
Chemistry
Math
History
English
History
Physics
Chemistry
Math
English
Introductory Geology
Field School
Synthesis & Application
Specialization
Employment Season
Field
Generalization
Year 1
Year 2
Year 3
Year 4

Department of Geology
September 1984

Figure 1. Interrelationship of courses at Saint Francis Xavier University.

In addition, many geology students obtain employment in geological work during the summer. This is regarded as an effective extension of their classroom and laboratory experience.

FACULTY

Here is a brief outline of the geology teachers at St. Francis Xavier University:

R. F. Cormier, Ph.D. (M.I.T.), has taught at St. Francis Xavier for 25 years. He teaches courses relating to the basic constituents of rocks and he also teaches geochemistry. The age determination of rocks, using the ratio of radioactive rubidium to strontium, is his major research activity.

K. Greenidge, Ph.D. (Harvard), teaches introductory courses in oceanography, geomorphology and Pleistocene geology. His research interests combine oceanography, botany and Pleistocene geology. Northern Cape Breton, Aspy Bay and northern mainland Nova Scotia have been the locale of much of his research effort.

William S. Shaw, Ph.D. (M.I.T.), is Chairman of the department and teaches oil and gas geology, coal geology, stratigraphy and geophysics. He came to St. Francis Xavier after a long career in oil exploration. Oil, coal, salt and ore deposits are his chief research interests.

H. C. Teng, M.Sc. (Memorial), will receive his Ph.D. this year from the University of New Brunswick. Professor Teng teaches fundamental properties and recognition of minerals, in addition to structural geology and ore deposits. A strong background in applied mining geology, together with his research interest in ore deposits, make his courses particularly effective.

J. Brendan Murphy, Ph.D. (McGill), teaches courses concerning the origin of igneous and metamorphic rocks, regional structural geology and optical mineralogy. His research interests at present concern the geological evolution of the Antigonish Highlands area and the evaluation of its mineral potential.

Cynthia Murphy, B.Sc. (McGill), is completing her M.Sc. thesis with McGill University in Montreal, Quebec. At present, she is instructing sedimentology and is responsible for laboratories in advanced courses. Her current interest is the geology of the Gaspé Peninsula in Quebec where she is studying the magmatic history of granitic and volcanic rocks.

SAINT MARY'S UNIVERSITY
DEPARTMENT OF GEOLOGY

The geology department of Saint Mary's University offers a complete undergraduate program leading to geology major and honours degrees. The department consists of 6 faculty members, 2 adjunct professors, 2 part-time instructors and 2 full-time technicians. Average enrollment is about 50 geology majors and 7 honours students.

Research facilities in the geology department include equipment for X-ray fluorescence and neutron activation analysis, photomicroscopy, thin section preparation and rock crushing, labs for geochemistry, micropaleontolgy and sedimentology, and a darkroom and drafting room. Students also have access to the University VAX-11 computer.

FACULTY

J. Dostal, Ph.D. (McMaster)	Igneous Petrology, Economic Geology
J. Greenough, Ph.D. (Memorial)	Volcanology, Geochemistry
G. Pe-Piper, Ph.D. (Cambridge)	Mineralogy, Geochemistry
Q. A. Siddiqui, Ph.D. (Leicester)	Micropaleontology, Biostratigraphy
J. Waldron, Ph.D. (Edinburgh)	Sedimentology, Structural Geology
D. H. Williamson, Ph.D. (Aberdeen) (Dean of Science)	Crystallography, Mineralogy

PART-TIME INSTRUCTORS

U. Grigg, M.Sc. (Cambridge)	Micropaleontology
P. Elias, M.Sc. (Memorial)	K/Ar Dating

ADJUNCT PROFESSORS

J. D. Keppie, Ph.D. (Glasgow) (N.S.D.M.E.)	Appalachian Geology and Tectonics
G. L. Williams, Ph.D. (Sheffield) (A.G.C. - B.I.O.)	Palynology of Mesozoic-Cenozoic of Eastern Canada, Regional Geology of Baffin Island, Lithostratigraphy

VISITING RESEARCHERS

C. N. Kotopuli, (Geological Laboratory, University of Patras, Patrae, Greece)	Mineralogy, Petrology
M. Zhai, (Institute of Geology, Academica Sinica, Beijing, China)	Geochemistry

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JURASSIC FOSSILS FROM THE SCOTS BAY FORMATION

*B. Cameron**

The Scots Bay Formation is a chert-bearing, mixed carbonate and siliciclastic, non-marine unit with a maximum thickness of 8 m of exposure in the southern Fundy Basin (Fig. 1). The formation is at the stratigraphic top of the Fundy Group in Nova Scotia. There has not yet been any definitive, well preserved paleontological evidence of a Jurassic age for the outcrop of the Scots Bay Formation in the type area, however, a newly discovered fossil assemblage of silicified microgastropods and ostracodes (Fig. 2) indicates a Jurassic age. In addition to microgastropods and ostracodes, silicified bivalve fragments and charaphyte (algal) stems, fish(?) coprolites, small fish teeth and scales, and silicified stromatolites are being studied. Many of the jasperoid chert nodules are centred by the well preserved woody tissue of tree trunks (Cameron et al., 1985; Cameron, 1985).

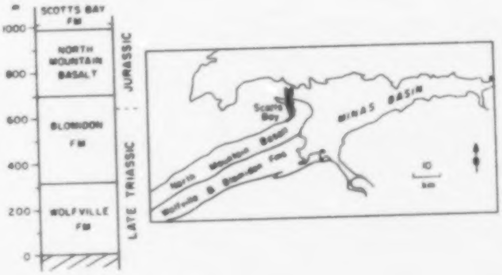

Figure 1. Map and stratigraphic column showing the type area and stratigraphic position of the Scots Bay Formation.

The fauna confirms the interpretation of a nearshore lacustrine paleoenvironment. Possibly, the Scots Bay lake or lakes(?) may have formed in collapse structures at the top of the North Mountain Basalt. Early silicification suggests an association with siliceous hot springs.

Fossils have been known from the Scots Bay Formation since the turn of the century, but identifiable microfossils were never extracted, although Thompson (1974) suggested the presence of the minute freshwater prosobranch gastropod *Hydrobia* in this section. This report documents three new microgastropods. A high spired, axially ribbed form is assignable to *Hydrobia* which has been questionably reported once from the Permian, but otherwise ranges from Late Jurassic to Recent. *Valvata* is another freshwater prosobranch which is smooth, umbilicate and low spired. It has been reported from Upper (possibly Middle) Jurassic to Recent strata. *Gyraulus (=Planorbis)* is a discoidal freshwater pulmonate gastropod known only from Late Jurassic to Recent time. Two freshwater ostracode genera have also been identified. *Darwinula* is long-ranging (Paleozoic to Recent), but *Metacypris* is restricted to Jurassic to Recent deposits.

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*Department of Geology, Acadia University, Wolfville, Nova Scotia

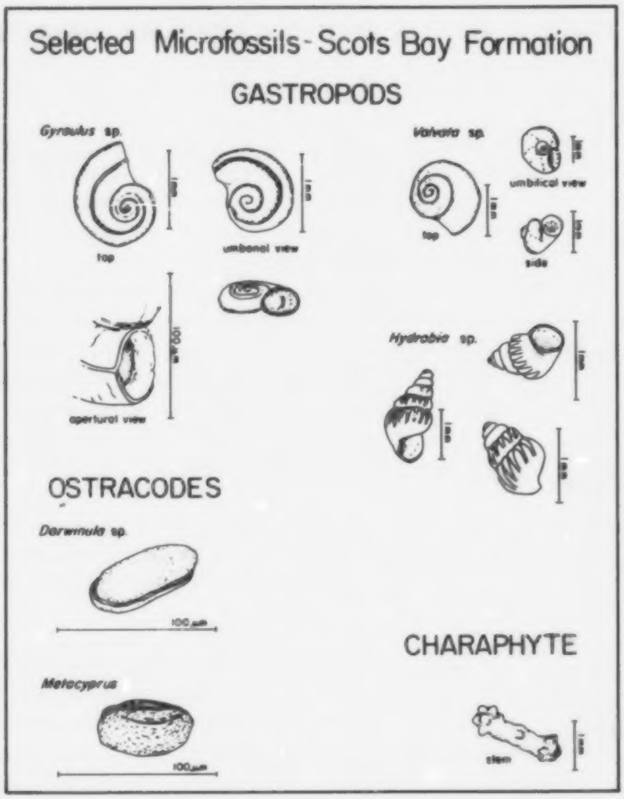
Selected Microfossils - Scots Bay Formation
GASTROPODS
Gyraulus sp.
top
umbonal view
100 µm
apertural view
Valvata sp.
umbilical view
top
side
Hydrobia sp.
OSTRACODES
Darwinula sp.
100 µm
Metacyprus
100 µm
CHARAPHYTE
stem

Figure 2. Morphology of selected microfossils from the Scots Bay Formation.

This fauna resembles, at the generic level, the freshwater invertebrate faunas of the Late Jurassic Morrison Formation of North America and the Purbeck Beds of Europe. Because none of these species have been previously described, they probably represent an older Jurassic assemblage. Although no freshwater pulmonates are known from rocks older than Late Jurassic, little is known about earlier non-marine Jurassic fossils throughout the world and they probably had a long pre-Late Jurassic evolutionary history.

Many workers speculate that the Scots Bay Formation is Early Jurassic in age. The K-Ar isochron of Hayatsu (1979) dates the underlying North Mountain Basalt at 191 ± 2 Ma, corresponding to latest Early Jurassic (=Toarcian) (Palmer, 1983). Although these fossils do not conflict with an Early or Middle Jurassic age for the Scots Bay Formation, their morphological similarities with Late Jurassic species may favor a Toarcian or younger age.

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GEOCHEMICAL CHARACTERIZATION OF THE GOLDENVILLE-HALIFAX TRANSITION OF THE MEGUMA GROUP OF NOVA SCOTIA: PROGRESS REPORT*

*M. C. Graves and M. Zentilli***

The transition zone between the sandy Goldenville and shaly Halifax Formations of the Cambro-Ordovician Meguma Group appears to be a significant control for metal concentration. Metasedimentary members within and immediately underlying the basal black slates of the Halifax Formation are preferentially enriched in Mn, Ba, Pb, Zn, Cu, As and Au over other members of the Goldenville-Halifax transition zone (GHT).

The GHT has a distinct lithogeochemical signature which can be seen over several metres in most sections of the contact from Yarmouth to Canso and can be stretched out vertically over several hundred metres of section in the south central portion of the outcrop area. In the central portion of the outcrop area from Halifax to Sheet Harbour, the GHT is marked by a distinct rock unit characterized by Bailey (1896) as banded argillite and by O'Brien (1986) as the Moshers Island Formation. This unit has been described in detail and lithogeochemical work is in progress in five sections from the central part of the Meguma Group outcrop belt: the east shore of Tancook Island, Halifax International Airport, north Halifax and north Dartmouth, the Caribou gold district as drilled in 1981 by Sherritt-Gordon Mines Limited, and the Lake Charlotte manganese occurrence drilled in September 1986 by the Nova Scotia Department of Mines and Energy. In all sections this distinctive rock unit is in excess of 100 m thick, uniformly fine grained and manganiferous. Correlation based on lithology between these sections and those reported last year (1985) is good. Lithogeochemical characterization and correlation is in progress.

Mapping of this unit should be an important prerequisite to assessment of the contact for mineralization. The widespread geographic extent of these anomalies gives further support to the concept that metal enrichment at this horizon is a regional feature with metallogenic, environmental and exploration significance.

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**Cuesta Research Limited, Halifax, Nova Scotia

STRATIGRAPHY AND SEDIMENTOLOGY OF THE GOLDENVILLE - HALIFAX TRANSITION IN THE TANCOOK ISLAND AREA, SOUTH SHORE*

J. W. F. Waldron**

The transition zone between the Goldenville and Halifax Formations in the LaHave River and Mahone Bay areas, Nova Scotia, contains a number of distinct mappable units first recognized by O'Brien (1985, 1986). The transition zone and underlying and overlying units are well exposed on Big and Little Tancook Islands and on the adjacent mainland coast at Blandford (Fig. 1). In this area, O'Brien (1986) divided the exposed succession into four members. The lowest, the New Harbour Member, represents typical Goldenville rock types, predominantly very thickly (>1 m) bedded sandstones with only minor amounts of slate. The overlying Tancook Member is characterized by subequal amounts of thinly (3-10 cm) to thickly (30 cm - 1 m) bedded sandstone and green laminated and unlaminated slate. This unit is in turn overlain by manganiferous laminated argillites of the Moshers

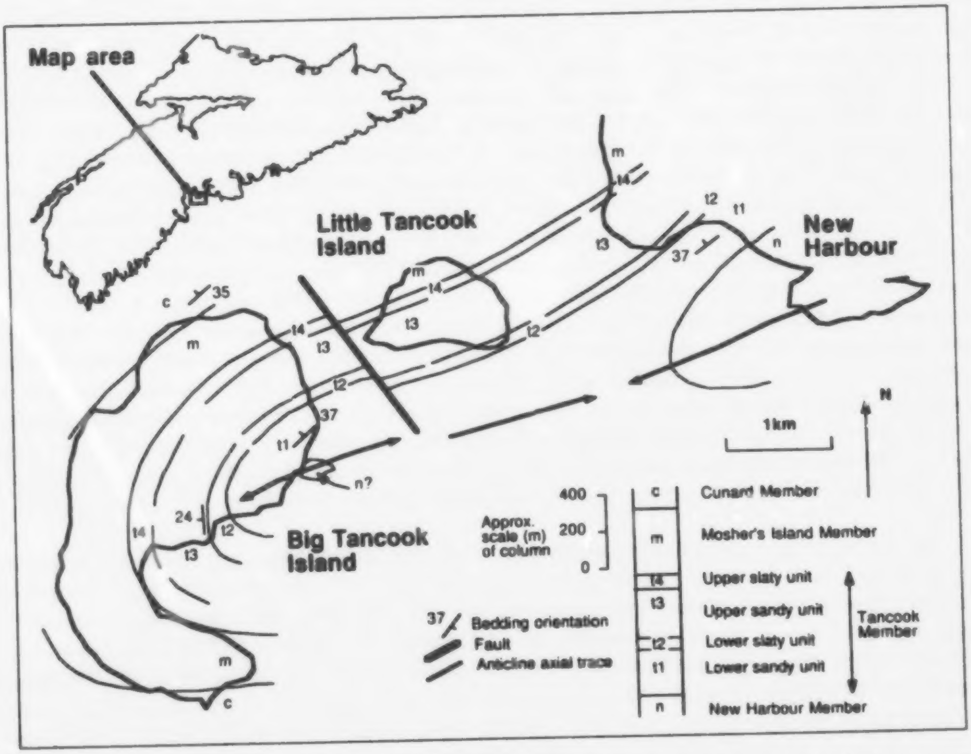
Map area
Little Tancook Island
New Harbour
Big Tancook Island
m
t4
t3
t2
t1
n
c
35
37
24
n?
1km
N
400
200
0
Approx. scale (m) of column
c
Cunard Member
m
Mosher's Island Member
t4
Upper slaty unit
t3
Upper sandy unit
t2
Lower slaty unit
t1
Lower sandy unit
Tancook Member
n
New Harbour Member
37
Bedding orientation
Fault
Anticline axial trace

Figure 1. Map showing location and stratigraphic subdivision of the Goldenville-Halifax transition zone in the Tancook Island area.

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**Department of Geology, St. Mary's University, Halifax, Nova Scotia

Island Member and then by graphitic, pyrite-bearing, thinly bedded slates and siltstones of the Cunard Member. All units have been deformed and metamorphosed to lower greenschist facies producing a slaty cleavage in the finer grained units and a local pressure-solution cleavage in the sandstone.

Within the Tancook Member, it is possible to recognize and correlate four (t1-t4) stratigraphic units (Fig. 1). The lower sandy unit consists mainly of very thinly (1-3 cm) to medium (10-30 cm) bedded sandstones and siltstones showing complete and partial Bouma sequences, representing deposition by low concentration turbidity currents. Rare bioturbation structures are mainly bedding-parallel sole marks. The lower slate unit consists of green slates which vary from finely laminated and manganiferous to mottled and completely homogeneous. Poorly laminated intervals contain abundant and well preserved burrows in a variety of orientations, suggesting that homogenization of the mottled intervals was enhanced due to bioturbation. Sandstones in the upper sandy unit vary from very thinly bedded, locally bioturbated layers to very thickly bedded units with dewatering structures and internal scours. These are interpreted as deposits of high concentration turbidity currents. Towards the top of the upper sandy unit, a single 45 cm layer of bioclastic limestone, containing echinoderm debris, is exposed on Big Tancook Island. The upper slaty unit consists of subequal amounts of slate and sandstone, however groups of sandstone beds occur locally where the relative proportions are up to 90% sandstone and 10% slate. This unit also contains common concretions of manganese-bearing carbonate. The sandstones contain frequent steep spreite burrows resembling *Teichichnus sp.* Towards the top of the unit, however, bioturbation disappears and both slates and sandstones contain undisturbed fine parallel laminations and cross-laminations.

The overlying Moshers Island Member is everywhere finely laminated, containing only rare low amplitude ripple laminations and pseudonodules. The slate contains brown-weathering, manganese-rich concretions which increase in abundance upwards. Colour variations in the generally greenish slates suggest a varying content of organic matter. Abundant disseminated garnet grains (probably spessartine) are visible in thin section; in the field they give a sandy appearance to the otherwise fine grained rocks.

The transition between the Moshers Island Member and the Cunard Member is an approximately 3 m thick zone marked by the appearance of disseminated pyrite and a change from predominantly grey-green to predominantly black graphitic slates. Thinly bedded siltstones appear slightly higher in the section. The Cunard Member also contains rare thick beds of dark, fine grained sandstone.

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PRELIMINARY REPORT ON REMAPPING OF AREAS OF THE WESTERN COBEQUID HILLS, NOVA SCOTIA*

*G. Pe-Piper***

INTRODUCTION

A series of Late Proterozoic and Paleozoic rocks outcrop north of the Cobequid Fault in the western Cobequid Hills of northern Nova Scotia (Donohoe and Wallace, 1982; 1985). The principal rock units are the late Hadrynian Jeffers Formation (volcanic and sedimentary rocks) which is cut by a dated latest Hadrynian diorite intrusion, shale of the Silurian Wilson Brook Formation, Devono-Carboniferous rhyolite and basalt of the Fountain Lake Group, and a series of Carboniferous plutons.

The Jeffers Formation and some adjacent rocks in the western Cobequid Hills were remapped during the summer of 1986. Particular attention was paid to establishing a basic stratigraphy and the sequence of hypabyssal intrusions within the Jeffers Formation. In addition, the petrography and structural setting of the major plutons were investigated.

JEFFERS FORMATION STRATIGRAPHY

It is proposed to elevate the Jeffers Formation to Group status and to define three new formations within the Jeffers Group (Pe-Piper, in press). The Gilbert Hills Formation comprises two members. The Lakelands Member consists principally of felsic pyroclastic rocks, with minor felsic and mafic flows and interbedded volcaniclastic sediments. The stratigraphically higher Harrington River Member consists of mafic and intermediate volcanic rocks that overlie volcaniclastic sediments with a mafic source. The Humming Brook Formation, interbedded with the Gilbert Hills Formation, consists of slightly laminated silty argillite, interpreted as a deep water sedimentary facies. The Cranberry Lake Formation comprises turbidites derived from a variety of volcanic sources. Some are highly lithic or arkosic whereas others are very silicic. A variety of turbidite facies are also represented, ranging from coarse, thick bedded sandstones of proximal character to thinly bedded, silty turbidites of more distal character.

STRUCTURE OF THE JEFFERS FORMATION

Donohoe and Wallace (1982, 1985) recognized that the Jeffers Formation had a distinctive shallow to moderately dipping foliation. Its age is defined locally where it is cut by the latest Hadrynian Jeffers Brook diorite. Elsewhere, it is cut by probable Silurian rhyolite dykes and unconformably overlain by undeformed rocks of the Fountain Lake Group. The

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**Department of Geology, St. Mary's University, Halifax, Nova Scotia B3H 3C3.

intensity of the flat lying deformation is spatially very inhomogeneous. The presence of a strong flat lying foliation of Carboniferous age in the Cape Chignecto Pluton suggests that some of the flat lying deformation of the Jeffers Formation may be of Late Paleozoic age.

CARBONIFEROUS PLUTONS

Some remapping was done on the Carboniferous plutons of the Advocate area with J. Waldron. Donohoe and Wallace (1982) demonstrated a Carboniferous age for the Cape Chignecto Pluton, northwest of Advocate, and mapped the southern part as highly deformed. They also mapped a crosscutting "Soldier Brook Diorite", which has also been dated as Carboniferous (Pe-Piper and Piper, in press). The entire granite-diorite complex in this area is strongly lineated and foliated, and the diorite consists of complex slices rather than being a single pluton. Granites and diorites previously mapped as the Fire Tower and New Yarmouth Plutons are continuous with and lithologically and structurally identical to the Cape Chignecto Pluton. The Apple River Pluton, northeast of Advocate, is also lithologically, petrographically and structurally similar to the Cape Chignecto Pluton, of which it is therefore interpreted to form a part.

This ductile deformation of the Cape Chignecto Pluton appears to predate the Early Carboniferous Greville River Formation and appears to result from thrusting motion to the northwest. It thus probably correlates with similar deformation in the St. John area of southern New Brunswick.

Mapping of the margins of Carboniferous plutons between Parrsboro and Five Islands has not revealed any intrusive contacts with the Fountain Lake Group. This observation, together with the Carboniferous radiometric dates for the Fountain Lake Group in the Parrsboro area (Donohoe and Wallace, 1982) may indicate that these volcanic rocks are synchronous extrusive equivalents of the plutons.

MINERALIZATION

Pyritic zones have been observed (1) stratabound within parts of the Jeffers Formation volcanic sequences, (2) stratabound within rhyolites at the base of the Wilson Brook Formation, (3) along faults adjacent to the Jeffers Brook diorite and (4) with rhyolite dykes of probable Silurian age. Minor sphalerite was found in a Jeffers Formation skarn on the North River.

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GEOLOGY OF THE CENTRAL AND SOUTHERN ANTIGONISH HIGHLANDS*

J. B. Murphy**

The central and southern Antigonish Highlands are predominantly underlain by late Precambrian rocks of the Georgeville Group. At the base of the Georgeville Group is the Keppoch Formation which is subdivided into two members. The lowest member contains subaerially deposited, interlayered rhyolites, basaltic andesites and basalts, and the upper member contains a similar sequence of volcanic rocks with interlayered, thinly laminated mudstones. The Keppoch Formation is conformably to unconformably overlain by a thick sequence of turbidites. In general, the stratigraphy documents the progressive development of a sedimentary basin.

This basin closed in the late Precambrian and was heterogeneously deformed. In the northern part of the area the rocks are polydeformed, whereas in the south deformation is generally mild although locally intense adjacent to shear zones. Greenschist or subgreenschist facies metamorphism accompanies this deformation. Appinitic gabbros post-tectonically intruded the Georgeville Group in the latest Precambrian.

Cambrian to Lower Ordovician rocks are not represented in the study area. Upper Ordovician-Lower Devonian rocks are assigned to the Arisaig Group. They consist of basalt and rhyolite within interlayered conglomerate and arkose, overlain by a thick sequence of fossiliferous siliciclastics. In general, the sequence documents a marine transgression. These rocks were heterogeneously deformed in the Middle Devonian. This deformation was generally mild but was intense adjacent to faults where an S-C fabric was developed. Granitic plutons of probable Devono-Carboniferous age are spatially associated with faults.

Economically interesting pyritic zones occur in several places in the Antigonish Highlands. They occur within the Precambrian volcanics, along shear zones and in particular along the Browns Mountain Fault.

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**Department of Geology, St. Francis Xavier University, Antigonish, Nova Scotia

GEOLOGICAL MAPPING IN THE CAPE BRETON HIGHLANDS NATIONAL PARK*

S. M. Barr**, R. P. Raeside**, C. E. White** and W. Yaowanoiyothin**

During June and early July 1986, an area of 800 km^2 encompassing much of Cape Breton Highlands National Park was mapped at a scale of 1:25 000, and crystalline rocks were sampled for petrological studies and radiometric age dating. Remapping of the central and eastern Cape Breton Highlands (Raeside et al., 1984; Barr et al., 1985; Raeside et al., 1986) is thus complete and compilation of the maps at a scale of 1:50 000 is now in progress. Future field studies in the region will focus on more detailed investigations to clarify igneous, metamorphic and structural history.

Previous mapping to the south of the 1986 map area (Raeside et al., 1984; Barr et al., 1985; Raeside and Barr, in press); showed that area to be dominated by diorite, tonalite and distinctive granodioritic to granitic plutons ranging in age from Precambrian to Devonian. The Cheticamp Lake gneiss is inferred to be the oldest unit and is in fault contact with the Hadrynian(?) McMillan Flowage Formation, a continental margin accumulation of sandstones and siltstones, volcanic and volcaniclastic rocks, and rare calcareous rocks. In contrast, previous work north of the 1986 map area (Raeside et al., 1986; Barr et al., in press) showed that in the northernmost highlands, north of the Wilkie Brook and Red River Faults, basement rocks of Grenvillian type and age are exposed, consisting of quartzofeldspathic and syenitic gneiss intruded by anorthosite, monzodiorite and syenite. Southeast of the Wilkie Brook Fault, very different gneissic rocks of the Cape North Group and metavolcanic-metasedimentary rocks of the Money Point Group are exposed along the Cape North Peninsula.

The 1986 map area fills in the intervening block between these previous map areas. Although assessment of the data is still in progress, some preliminary interpretations can be made. The mapping confirmed that the Grenvillian basement rocks are unique in the highlands and do not extend south of the V-shaped junction between the Red River and Wilkie Brook fault systems. It also showed that the Cape North and Money Point Groups can be traced into the northern part of the National Park south of the Aspy River. In this area a more extensive section of mica schist and muscovite-bearing quartzite, which appears to lie stratigraphically above the Cape North Group, is exposed. These units cannot be directly correlated with metamorphic units in the eastern or western highlands to the south because of the intervening presence of orthogneissic and granitoid rocks. Petrologic studies now in progress may show whether or not correlations can be made. The Cheticamp Lake gneiss (Raeside et al., 1984) continues from the south into the 1986 map area but also appears to be terminated by intrusive units.

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**Department of Geology, Acadia University, Wolfville, Nova Scotia B0P 1X0

A schistose unit lies north and east of the Cheticamp Lake gneiss, but much of this occurs as pendants, screens and xenoliths in granitoid rocks of probable Devonian age which are the predominant rocks in the map area. These granitoid rocks are mainly biotite granodiorite to granite with 'S-type' characteristics. However, the area also includes two megacrystic granitoid units, the Margaree Pluton in the west and the Cameron Brook Pluton in the southeast. The McMillan Flowage Formation continues north of Clyburn Brook to the west of the Cameron Brook Pluton, where it is terminated by a major mylonitic shear zone which also affects the Devonian granites. This major structural zone marks the boundary between the Devonian granites to the north and the typical central highlands granitoids to the south.

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GEOLOGY OF THE JUMPING BROOK METAMORPHIC SUITE, WEST-CENTRAL CAPE BRETON HIGHLANDS*

*R. A. Jamieson**, H. E. Plint**, K. A. Connors**, P. Tallman** and J. A. Marcotte***

The Jumping Brook Metamorphic Suite extends from French Mountain in the northwestern Cape Breton Highlands through the Cheticamp River to the Margaree Valley and the central Highlands. Formal nomenclature and subdivisions of these rocks, modified and extended after Currie (in press) on the basis of 1:10 000 and 1:25 000 mapping in 1985 and 1986, are presented here for the first time.

The lowest unit is the Faribault Brook Metavolcanics, a sequence of predominantly mafic to intermediate volcanic and volcaniclastic rocks which outcrop extensively south of the Cheticamp River. They are structurally overlain by the Rocky Brook Schist, which includes a prominent boulder conglomerate at its base, succeeded by quartz-rich metasedimentary rocks and foliated felsic tuffs. These are followed by the Dauphinee Brook Schist, which consists of low- to medium-grade interbanded pelitic and semi-pelitic metasedimentary rocks extending from the vicinity of the Cheticamp River north to Jumping Brook. These rocks are structurally overlain by the Corney Brook Schist, comprising medium- to high-grade pelitic and semi-pelitic schists with minor quartzite and marble. The George Brook Amphibolite, metabasite with common relict dioritic textures, is widespread within the higher grade parts of the sequence.

The entire sequence has been metamorphosed and deformed, with metamorphic grade and structural complexity increasing to the north and east. An early stage of isoclinal folding and transposition was followed by veining and further flattening, the latter accompanied by prograde metamorphism and associated porphyroblast growth. The development of major north-south trending folds and crenulations post-dated the metamorphic peak. The suite has been extensively disrupted by later shearing and faulting.

The Jumping Brook Metamorphic Suite is interpreted as a volcanic-sedimentary complex, involving early mafic volcanism succeeded by felsic volcanism. The centre of silicic volcanism was to the southeast, possibly in the Crowdis Mountain area, whereas sedimentary rocks predominated in the north, with the transition between the two in the vicinity of the Cheticamp River. However, given the structural and metamorphic complexity of the belt, both stratigraphic and structural breaks may occur and the present sequence may not be the original one. The rocks have generally been interpreted as Upper Proterozoic, but new evidence supports the suggestion of Currie (1982) that they may be Lower Paleozoic.

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**Department of Geology, Dalhousie University, Halifax, Nova Scotia B3H 3J5

Numerous small massive sulphide deposits south of the Cheticamp River are associated with the transition from mafic volcanics to overlying felsic volcanic and sedimentary rocks. The sulphides partly pre-date metamorphism, but are locally re-moblized in shear zones. No single model for the origin of the deposits applies to all of them. Further detailed investigations are planned within the stratigraphic, structural and metamorphic framework presented here.

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THE GEOLOGY OF LATE HADRYNIAN METAVOLCANIC AND GRANITOID ROCKS OF THE COXHEATH HILLS - NORTHEASTERN EAST BAY HILLS AREA, CAPE BRETON ISLAND, NOVA SCOTIA*

*M. J. Thicke***

During the summer of 1986 the Coxheath Hills and the East Bay Hills northeast of Ben Eoin were mapped and sampled as the basis of an M.Sc. thesis project. Rock units within the study area include late Hadrynian metavolcanic and granitoid rocks and Cambro-Ordovician, Devonian and Carboniferous clastic sedimentary rocks. The purpose of this study is to describe the field relations, petrography and geochemistry of the metavolcanic and granitoid rocks, and to interpret their origin, tectonic setting and economic potential.

Late Hadrynian metavolcanic rocks in the study area belong to the Fourchu Group. In the Coxheath Hills area, and in the Spruce Brook area to the southwest, they consist primarily of intermediate to felsic tuffs, crystal tuffs and crystal lithic lapilli tuffs. Subordinate basaltic to rhyolitic flows are interlayered with the pyroclastic rocks. Northeast striking volcanic layering of unknown origin may be present in some flows. Throughout the northeastern East Bay Hills area the metavolcanic rocks consist predominantly of mafic to intermediate flows and pyroclastic rocks. Felsic flows and tuffs occur in lesser amounts. The metavolcanic rocks in the study area have been metamorphosed to subgreenschist to greenschist facies.

Three granitoid plutons of probable late Hadrynian age have intruded the Fourchu Group metavolcanic rocks within the study area: the Coxheath Pluton in the Coxheath Hills, the Spruce Brook Pluton about 10 km southwest of the Coxheath Pluton and the MacEachern Lake Pluton northeast of Ben Eoin in the East Bay Hills. These complex plutons consist of variably textured, fine- to coarse-grained hornblende dioritic to hornblende granitic phases.

The metavolcanic and granitoid rocks have been deformed to different intensities throughout the study area. Predominant foliation strikes northeast and a weaker(?) fabric strikes north to north-northwest. It appears that deformation has been more intense in the East Bay Hills than in the Coxheath Hills.

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**Department of Geology, Acadia University, Wolfville, Nova Scotia BOP 1X0

GEOLOGY OF THE GUYSBOROUGH - COUNTRY HARBOUR AREA*

*J. D. Hill***

The second phase of a two to four year mapping project on the granitoid plutons in the eastern Meguma Terrane was centered on the geology of the area between the town of Guysborough and Country Harbour in 1986. Although field work was done at a scale of 1:10 000, the final map will be at 1:50 000 due to the scarcity of outcrop. In general, the area is underlain by metasedimentary rocks of the Cambro-Ordovician Meguma Group which are intruded by several Devonian(?) granitoid plutons. The area is bounded by major transcurrent faults on the north and west (Guysborough County Fault) and southwest (Country Harbour Fault). The area was previously mapped by Faribault (1893) and Schiller (1961). The general geology has been described by Schiller (1963) and Haynes et al. (1986) studied the structure of the Mile Lake gold deposit. Harmeson (1986) has analyzed the relationships between aeromagnetic anomalies, Landsat images and geologic contacts.

The oldest rocks in the map area belong to the Goldenville Formation and overlying Halifax Formation of the Meguma Group. Although some differences were recognized between various outcrops of the older Goldenville Formation, the formation could not be subdivided at map scale due to insufficient outcrop and lack of lithologic continuity. The Goldenville Formation varies from relatively massive meta-arenite and metawacke to thinly bedded metawacke containing minor amounts of biotite-muscovite schist and phyllite. Although porphyroblasts are generally lacking, garnet and rare cordierite occur locally in more pelitic beds and staurolite occurs in three thin horizons at Forest Hill. Sillimanite fibers occur in metawacke interlayered with granite sills east and south of Ogden. The younger Halifax Formation is divided into a lower unit of rusty graphitic schist and upper unit of grey phyllite containing minor thin coticule beds. Both units of the Halifax Formation typically contain 1-30% porphyroblasts of subhedral to euhedral andalusite and(or) anhedral, inclusion-rich cordierite up to 4 cm long.

Several granitoid plutons intrude the Meguma Group. They are divided into tonalite and biotite-muscovite granite to granodiorite. Although igneous terminology is used, all of the granitoid rocks have been deformed to varying degrees. Tonalite occurs as small bodies lying at the margins of larger granitoid plutons. Lack of outcrop prevented a clear observation of the shape of the tonalite bodies. Although the exact age of the tonalite is unknown, correlation with similar tonalite (though differing by lack of hornblende) in the Canso area (Hill, 1986) suggests it may have been deformed prior to intrusion of the younger, more felsic plutons. The granite to granodiorite plutons contain varying amounts of muscovite and biotite and are locally permeated by abundant pegmatite lenses, dykes and pods. Although different intrusions and rock types were recognized, no age sequence could be determined due to paucity of outcrop.

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**Geological Survey of Canada, Ottawa

Two main periods of ductile deformation have been recognized, in addition to several localized events of ductile and brittle deformation. The older event is represented by widespread development of a foliation that is typically oriented parallel or subparallel to bedding. This cleavage is believed to be related to regional gently plunging folds, of which the most easily recognized is the synclinorial structure occupied by the Halifax Formation in the area. The younger event is shown by a transposition foliation which is believed to be related to a regional dextral shearing event in the eastern Meguma Terrane.

Mapping was extended north and west of the Guysborough County Fault for about 1-2 km. Four units were distinguished: plagioclase-phyric andesite, dark grey phyllite, hematitic arenite, and lithic to feldspathic wacke and conglomerate. The andesite and phyllite are deformed and metamorphosed (lower greenschist grade) and thus appear to be older than the unmetamorphosed arenite and wacke-conglomerate units, although no contacts were observed. The lithic to feldspathic wacke and conglomerate unit, which locally contains Meguma Group pebbles, appears to be correlative with the lower Carboniferous Horton Group.

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STELLARTON BASIN PROJECT: 1986 PROGRESS REPORT[1]

G. Yeo[2], L. Daigle[3], M. D'Orsay[4], R. Gao[5], S. Palmer[6] and R. Snow[3]

New data allow the Late Carboniferous tectonostratigraphic history of Stellarton Gap to be refined. Figure 1 illustrates the structural and sedimentological evolution of Upper Carboniferous strata of Stellarton Basin.

CUMBERLAND GROUP

One of the enigmas of the Carboniferous stratigraphy of Nova Scotia is the New Glasgow Conglomerate. Upward increase in conglomerate:sandstone ratio in a borehole (P-58) drilled almost on the axis of the Trenton Syncline by the Nova Scotia Department of Mines and Energy Coal Division confirms interpretation of the New Glasgow Conglomerate as an alluvial fan complex which prograded northerly from the Cobequid - Hollow Fault system. The similarity of the early Westphalian B Middle River Formation, a sequence of red sandstone, siltstone and conglomerate, to the lower part of the New Glasgow Conglomerate, and its absence above the New Glasgow Conglomerate in this borehole suggests that the Middle River Formation is older than the New Glasgow Conglomerate, rather than younger as previously supposed. The last major episode of movement on the Cobequid - Hollow Fault system therefore must have begun in middle to late Westphalian B time.

STELLARTON FORMATION

As faulting continued a rhomb graben, in which the "Stellarton Formation" (Fralick and Schenk, 1981) was deposited, developed between the Cobequid and Hollow Faults.

The initial phase of graben subsidence and filling is represented by redbeds and grey beds of the Skinner Brook and Westville Members. These were deposited as basin margin alluvial fan and river deposits, and basin interior deltaic and lacustrine deposits respectively. Spore assemblages from the Westville coals indicate a Westphalian C to early Westphalian D age and mixed forest mire and bog conditions. Retrogradation of the Westville Member over the Skinner Brook Member suggests that basin margin relief was gradually reduced. Late Westville time therefore represents a period of relatively little fault movement.

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[1] Funded by Geological Survey of Canada under the Canada - Nova Scotia Mineral Development Agreement

[2] Geological Survey of Canada, Ottawa, Ontario

[3] Geology Department, Acadia University, Wolfville, Nova Scotia

[4] Geology Department, University of Western Ontario, London, Ontario

[5] Geology Department, University of New Brunswick, Fredericton, New Brunswick

[6] Geology Department, St. Mary's University, Halifax, Nova Scotia

The second phase of graben subsidence and filling is represented by the Plymouth and Albion Members which are, respectively, red basin margin fluvial deposits, and grey basin interior lacustrine deposits comparable to the Skinner Brook and Westville Members. Spore assemblages from the Albion coals indicate a late Westphalian C to Westphalian D age. They also suggest mixed forest mire and bog conditions. As with the earlier graben filling episode, basin interior grey beds replaced the marginal redbeds up-section, suggesting a period of increased faulting and renewed basin margin uplift, followed by reduced marginal relief and relatively little fault activity.

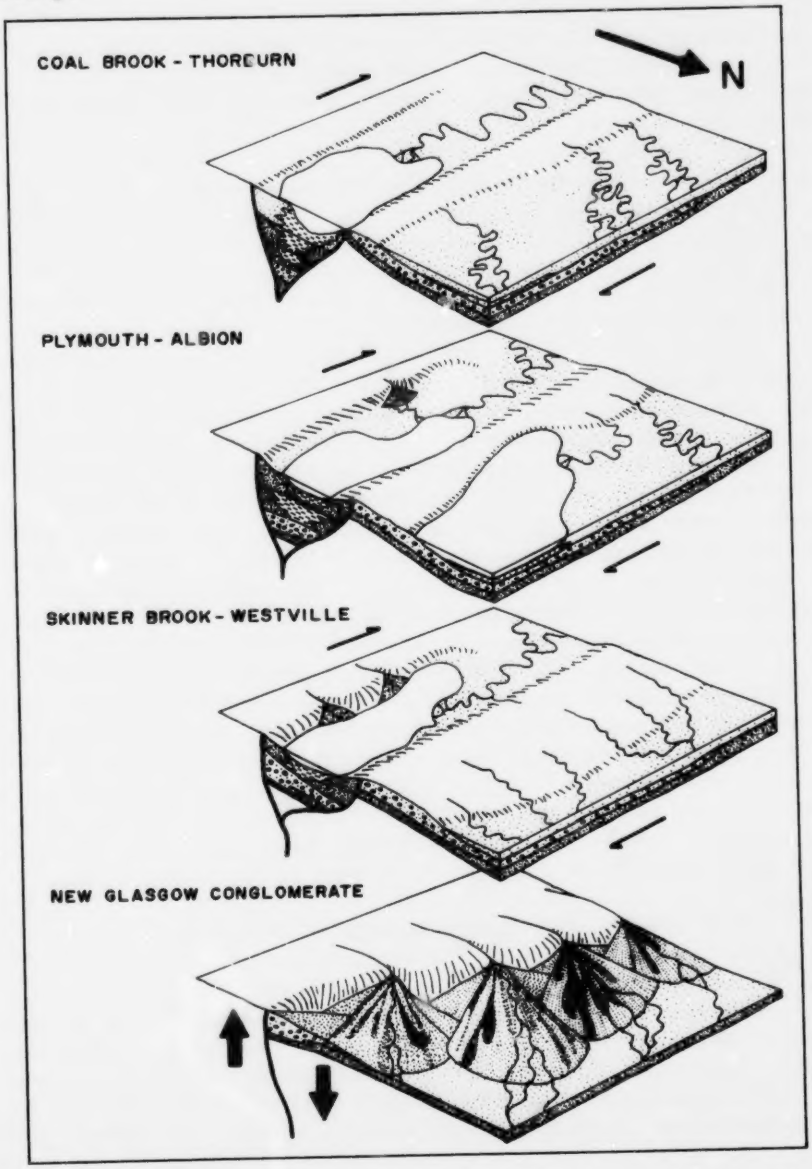
COAL BROOK - THORBURN
N
PLYMOUTH - ALBION
SKINNER BROOK - WESTVILLE
NEW GLASGOW CONGLOMERATE

Figure 1. Structural and sedimentological evolution of Upper Carboniferous strata of the Stellarton Basin.

The third phase of graben subsidence and filling took place during deposition of the Coal Brook and Thorburn Members. The basin depocentre had shifted eastward during this phase. Redbeds preserved along the southeastern edge of the graben suggest at least local marginal relief. The dark shales typical of the Coal Brook Member are relatively deep lake deposits. Either subsidence in the basin interior was at a maximum during Coal Brook time, or water levels within the graben stood higher, perhaps due to the cutoff of an earlier basin outlet. Progradation of more coarse grained, grey, lake margin and fluvial clastics of the Thorburn Member over the Coal Brook shales indicates reduced basin subsidence and, consequently, reduced fault activity. Spore assemblages from the Thorburn coals indicate a middle to late Westphalian D age. They suggest alternating forest mire and bog conditions. This is consistent with the presence of rooted underclays beneath the Thorburn coals, a feature uncharacteristic of older Stellarton coals.

Within the Stellarton Formation the reflectivity values of coals increase with age and depth, but the higher reflectivity values of Stellarton Formation coals compared to Pictou Group coals are better explained by anomalous heat flow within the graben.

PICTOU GROUP

The Merigomish Formation represents the Pictou Group in Stellarton Gap. This formation comprises predominantly grey, lithic, fluvial sandstones with minor conglomerates, interbedded with reddish floodplain mudstones. At the base of the Merigomish Formation, a sequence of light grey, partly calcareous, lacustrine sandstones and siltstones, locally with stromatolite beds, rests disconformably(?) on the New Glasgow Conglomerate. Spore assemblages from Merigomish Formation coals and oil shales indicate late Westphalian C-D ages. The Merigomish and Stellarton Formations are therefore contemporaneous. The coals were deposited under forest mire conditions. Channel sandstones are typically stacked in multistoried sets up to 100 m thick. Sediment dispersal in the Pictou Group was predominantly northerly. Low statistical variance in transport direction at outcrop scale suggests low sinuosity channels. Variability in transport direction at regional scale suggests high sinuosity rivers. The presence of incised channel bases and scoured reactivation surfaces and lack of well developed upward fining or decrease in scale of sedimentary structures suggest that the rivers were anastomosing. Based on these criteria it is difficult to suggest a single fluvial depositional model.

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CATCHMENT BASIN ANALYSIS OF STREAM GEOCHEMICAL DATA IN THE COBEQUID HIGHLANDS: PROGRESS REPORT*

*G. F. Bonham-Carter**, D. J. Ellwood** and P. J. Rogers*

The goal of this project is to integrate stream geochemical data from the Cobequid Highlands with bedrock geological data from the geological maps of Donohoe and Wallace (1982). This work has been completed for the easternmost map sheet (i.e. Map 82-9), has been discussed by Bonham-Carter et al. (in press) and Rogers et al. (1986), and is now being extended to the three remaining sheets.

Integration is carried out by means of catchment basin analysis. The catchment area upstream from each sample site is characterized geologically by determining the areal proportions of map units comprised. A statistical model allows the prediction of a geological background for each basin. After subtracting background, a residual anomaly map is produced for each element. The effects of scavenging by Fe and Mn can also be considered, and proximity to lithologic contacts can be modelled.

Besides extending this study geographically, the authors have been developing new ways to display the results in map form. For each element, it is useful to look at both the observed and residual levels on the same display. This can be achieved by superimposing filled circles at sample points on the catchment basin image. The filled circles are colour-coded to indicate observed levels, and the remaining catchment basin area is coded to indicate residual levels. In this way, the relative importance of background in enhancing or de-emphasising individual basins is more easily seen. Streams and lakes have also been digitally scanned, and can also be superimposed on the images, facilitating the orientation of the viewer.

Finally, an attempt is being made to represent the variability present in the data due to sampling and analysis by analyzing the relationship between concentration and variance present in field duplicates using a method developed by Thompson and Howarth (1976). Where the variance can be shown to be positively correlated with concentration, this information can be added to the map legend as ± the standard deviation at each element level.

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EASTERN NOVA SCOTIA DATA INTEGRATION: A PROGRESS REPORT*

*G. F. Bonham-Carter**, A. N. Rencz**, D. Wright**, J. D. Keppie,*
P. J. Rogers and R. R. Stea

A project to employ digital image analysis techniques for integrating multiple geological data sets is being carried out by the Mineral Resources Division of the Geological Survey of Canada, working co-operatively with members of the Nova Scotia Department of Mines and Energy. The goals of the project are (1) to develop and extend methodology for handling geological map data in digital form and (2) to produce maps that combine features from different data types in a way that is meaningful for appraising mineral resource potential. The study area lies between 44°45' to 46°00' latitude and 61°00' to 62°30' longitude, and encompasses part of Antigonish and Guysborough Counties.

The following maps are being hand digitized, using an Intergraph system at Canada Centre for Remote Sensing and raster-scanned by an Optronics laser scanner at Lands Directorate, Environment Canada: (1) bedrock geology, compiled at 1:150 000 from recently published maps; (2) faults from the same compilation but separated into a different digital file; (3) surficial geology; (4) catchment basins, drawn on a 1:50 000 topographic base, corresponding to catchment areas upstream from stream sample sites; and (5) the same as (4), but for lake sediment samples, mainly in the Meguma Zone. After digital processing, raster images are produced with a pixel size of 50 x 50 m. Catchment basins are linked by a lookup table to a geochemical file, so that a catchment basin image portraying the distribution of a single element, or a combination of elements, may be produced. The relationship of bedrock and surficial geology to lake and stream sediment geochemical data is being studied quantitatively, and anomaly maps, after removing geochemical variation which can be explained as due to geological background, are plotted digitally in colour.

Additional images for till geochemistry, Landsat Thematic Mapper (TM), aeromagnetics, radiometrics and gravity are being registered to a common base for an integration study which will attempt to highlight areas of coincident anomalies and areas of interest for mineral potential.

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**Geological Survey of Canada, Ottawa, Ontario

ZINC MINERALIZATION AT KIRKMOUNT: NATURE OF THE OCCURRENCE AND IMPLICATIONS FOR MINERAL EXPLORATION*

*A. L. Sangster***

INTRODUCTION

A regional stream geochemical survey by the Nova Scotia Department of Mines (Bingley, 1977) identified a strong stream geochemical Zn anomaly at Kirkmount, Pictou County, Nova Scotia. Subsequent exploration surveys and drilling (Sangster, 1978; 1980; Sangster et al., 1979) identified a large low grade Zn source in chloritic argillites and greywackes of the Late Precambrian James River Formation (Murphy, 1985). Drillhole 326-2 intersected 99 m averaging 0.91% Zn with assays to 11.2% Zn. No Zn sulphides were observed. This report presents a summary of the geology and distribution of Zn in non-sulphide Zn minerals in the Late Precambrian James River Formation from which the regional geochemical anomaly was derived.

GENERAL GEOLOGY

The Kirkmount Zn mineralization occurs in highly fractured argillite and greywacke (Fig. 1) (Sangster, 1986). The argillite is green to grey-green, massive to very thinly bedded, with an essential mineralogy of quartz, white mica and chlorite. The greywackes are grey to grey-green, fine- to medium-grained, and have an essential mineralogy similar to the argillite. Both rock types contain minor red hematite mottling and joints and fractures are coated with red-brown iron oxide, manganese oxides and minor specular hematite.

NATURE OF THE ZINC OCCURRENCE

Three types of non-sulphide Zn concentrations are present:

1. Willemite (Zn_2SiO_4), found in drillhole 326-2, is the most conspicuous and is identified by bright green, short wave, ultraviolet fluorescence. It occurs as radiating crystal growths on the walls of mm scale fractures in greywacke and to a lesser extent as minute local disseminations in argillite. The willemite is associated with manganiferous, low iron-magnesium calcite and very minor quartz.

2. Correlation of drill core analyses with willemite occurrence indicates that Zn assays up to 1.5% are present in rocks that do not contain willemite. Preliminary results indicate that a significant portion of this Zn is present in chlorite, with lesser amounts as an opaque, iron-free Zn-S complex.

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**Geological Survey of Canada, Mineral Resource Geology Division, Ottawa, Ontario

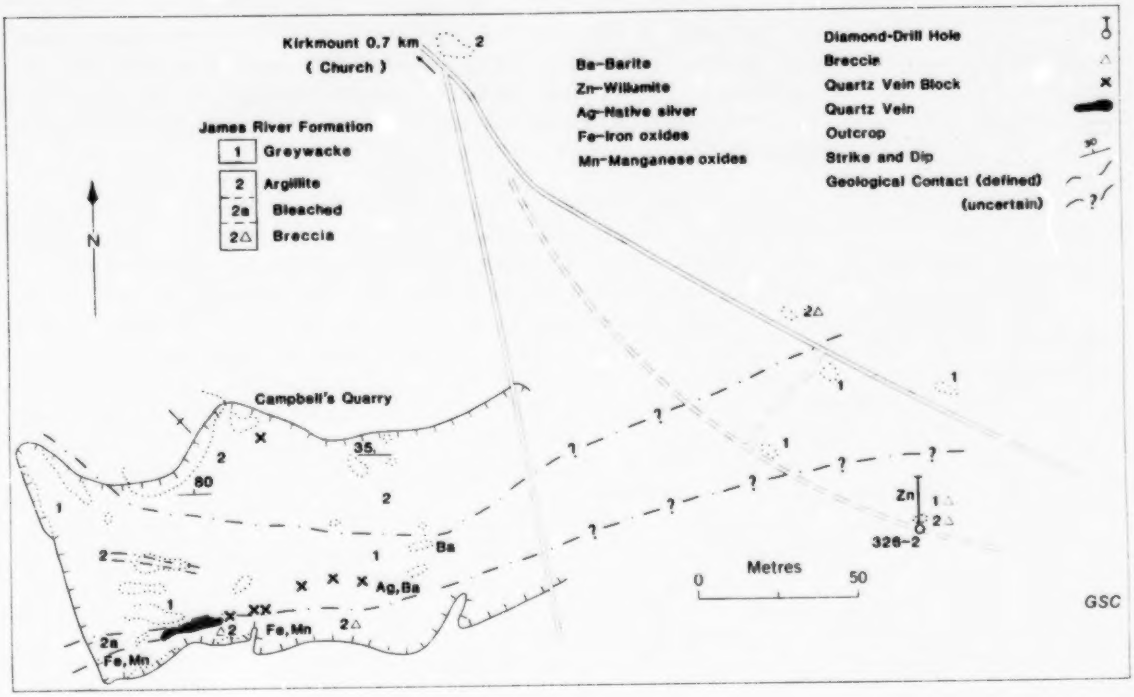
Kirkmount 0.7 km
(Church)
James River Formation
1 Greywacke
2 Argillite
2a Bleached
2△ Breccia
N
Ba-Barite
Zn-Willemite
Ag-Native silver
Fe-Iron oxides
Mn-Manganese oxides
Diamond-Drill Hole
Breccia
Quartz Vein Block
Quartz Vein
Outcrop
Strike and Dip
Geological Contact (defined)
(uncertain)
Campbell's Quarry
35
80
Ba
Ag,Ba
Fe,Mn
2a
Fe,Mn
Zn
326-2
Metres
0
50
GSC

Figure 1. Geology of the Campbell quarry area, Kirkmount, Nova Scotia (after Sangster, 1986).

3. Zinc is also present in solid solution (± 2%) in siderite, which forms the matrix of brecciated argillites on the south side of the Campbell quarry.

NATIVE SILVER OCCURRENCE

Minor native silver has been identified in carbonate veinlets cutting white, massive vein quartz along the northern edge of the Zn-bearing siderite breccia in the Campbell quarry. The genetic implications of this unusual association are not known at present.

SIGNIFICANCE TO MINERAL EXPLORATION

Two aspects of the Kirkmount willemite occurrence are important to mineral exploration in the Antigonish Highlands in particular and should probably be considered when prospecting other highland areas in Nova Scotia:

1. The presence of Zn-bearing carbonate and silicate minerals may have been overlooked previously during prospecting and evaluating Zn geochemical anomalies. Other anomalies, similar to that at Kirkmount, are known in the Antigonish Highlands and should be evaluated in light of this new information.

2. Willemite is normally a supergene mineral that forms in the oxide zone of Zn deposits in arid climates (Pough, 1941). If the Kirkmount willemite is secondary (and not an unusual primary occurrence?), formation during arid paleoclimatic conditions is indicated, possibly during the early Carboniferous or Jurassic, and exploration for a Zn-bearing protolith may be warranted. It is also noteworthy that one million tons of supergene willemite ore, grading 35% Zn, has been mined at Beltana, Australia (Muller, 1971; Rangott, 1980) and that significant quantities of willemite are associated with the oxidized zone of the Teneginski Pb-Zn deposit in the Soviet Union (Okhapkin et al., 1981).

The native Ag occurrence is the first described in pre-Carboniferous rocks in Nova Scotia and its economic potential is not known. This occurrence and similar rocks in the area should be evaluated for their Ag potential and for a possible relationship between native Ag and Au mineralization.

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REFLECTION SEISMIC STUDIES: CUMBERLAND BASIN, WESTERN CAPE BRETON ISLAND, NOVA SCOTIA*

J. A. M. Hunter and D. S. Bromley**

The Terrain Sciences Division of the Geological Survey of Canada has been carrying out reflection seismic studies in Cumberland County and western Cape Breton Island, Nova Scotia.

The two marine seismic surveys carried out off the west coast of Cape Breton Island, Nova Scotia, have been fully processed and returned to the Geological Survey of Canada. The primary objective of these investigations was to establish the structural geology offshore of Inverness and Port Hood, and by doing so provide control for projecting the depths of three major coal seams offshore.

One of the constraining factors is the lack of seismic data over the Inverness Thrust Fault. This fault closely parallels the coastline and occurs in very shallow water (5-15 m). Since the seismic lines could not be extended this close to shore, the direct correlation of coal seams to seismic events is hindered. However an extrapolation was made possible across the Inverness Fault by combining the observed data with a horizontal borehole drilled through this fault plane.

Based on the offshore and onshore structure, an average dip of 11° to the northwest was calculated for the Inverness coal seams and an estimated depth of 1100 ± 110 m was determined for the coal seam south of Port Hood Island.

Discussion is underway regarding publication of these results in conjunction with data collected by K. Gillis of Nova Scotia Department of Mines and Energy and P. Hacquebard of the Atlantic Geosciences Centre. The publication will incorporate all information gathered on the geology of the coal seams on the western side of Cape Breton Island, Nova Scotia.

The collecting of high resolution land seismic data over the Cumberland Basin area of Nova Scotia continued during June - September 1986. Results of the 1985 survey have been processed and several strong reflecting events can be observed over the 8 km profile. Figure 1 shows a section of the 8 km profile shot near Springhill. An additional 3 km of high resolution reflection data was collected in June 1986, extending westward into the Cumberland Basin. This work is being done in an attempt to obtain regional coverage of Carboniferous strata found in the Cumberland Basin and detailed structure of the coal-bearing strata near Springhill, Nova Scotia.

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*Funded by the Geological Survey of Canada under the Canada - Nova Scotia Mineral Development Agreement

**Geological Survey of Canada, Ottawa, Ontario

Results of the work completed to date have lead to the planning of a large-scale seismic survey over the Cumberland Basin. A further 50 km of high resolution seismic data are to be collected in the fall of 1986. This survey will be contracted out to private industry and run according to the parameters determined by prior work. On completion of this survey structural events will be interpreted and a lithological correlation with existing boreholes (drilled by Nova Scotia Department of Mines and Energy) will be attempted.

Figure 1. A portion of the seismic section shot on the Athol Road west of Springhill, Nova Scotia. Large reflectors are associated with coal-bearing strata found in the Cumberland Basin.

GEOLOGY AND ZINC MINERALIZATION, LIME HILL, NOVA SCOTIA*

*A. L. Sangster** and M. Justino****

INTRODUCTION

Zinc mineralization at Lime Hill was discovered in 1955 in rocks mapped as a roof pendant of Hadrynian George River Group marble in Paleozoic granitic rocks (Milligan, 1970). Several campaigns of mineral exploration outlined about 2 million tons of erratic, low grade zinc mineralization considered to be a contact skarn (Chatterjee, 1977). Sangster et al. (1985) indicated that better grade and width mineralization is related to steeply plunging fold hinges and suggested that future mineral exploration should consider structure as a possible ore control at Lime Hill. The mapping reported here was initiated to define the character of the host rocks and the extent of rocks favourable for the occurrence of undiscovered zinc mineralization in the Lime Hill area. Chemical and sulphur isotopic analyses were carried out to compare the mineralization to similar occurrences in the Grenville Supergroup.

GEOLOGY

Mapping at Lime Hill indicates that the zinc occurrence is within a marble - paragneiss complex, southwest of the Campbell Brook Fault, which is of different character than the exposed George River Group metasediments to the northeast of the fault. The more significant differences are itemized below:

1. Rock types - The George River Group at North Mountain is composed of dolomite and limestone with quartzite, slate, metagreywacke and minor metavolcanic rocks. The Lime Hill gneiss is a quartz-feldspar-biotite paragneiss with minor dolomite.

2. Metamorphic grade - The George River Group metasediments are low grade with well preserved bedding. The Lime Hill gneiss contains a quartz-feldspar-biotite±cordierite±sillimanite metamorphic mineral assemblage indicative of medium to high metamorphic grade. Primary features have not been observed.

3. Intrusive relationships - Both the Lime Hill gneiss and the George River Group are cut by large granitoid intrusions of probable Cambrian and(or) Devonian age. The Lime Hill suite is also cut by orthogneiss and several phases of granitic and mafic dykes that are not seen in the George River Group.

4. Structure - The Lime Hill gneiss shows a persistant north-south structural grain in contrast to northeast and northwest trends present in the George River Group.

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*Funded by Geological Survey of Canada under the Canada - Nova Scotia Mineral Development

**Geological Survey of Canada, Ottawa, Ontario

***Acadia University, Wolfville, Nova Scotia B0P 1X0

5. Aeromagnetic signature - The Lime Hill gneiss has a higher magnetic signature than is observed over George River Group rocks.

Preliminary interpretation of these results indicates that the Lime Hill gneissic complex may represent a basement to the George River Group.

GEOCHEMISTRY

Analyses (DCP multi-element package) of sphalerite-bearing and unmineralized marble associated with the occurrence indicate a similarity to Grenville occurrences (Sangster, 1970; Sangster and Bourne, 1982; deLorraine and Dill, 1982; Lea and Dill, 1968). The marble suite is strongly dolomitic with sphalerite associated either with siliceous dolomite or clean dolomite bordering areas of siliceous dolomite. The alumina content of the marble is low except in thin, feldspathic, calc-silicate units. Trace element analyses of mineralized marble indicate enrichment in Cd and Hg with minor Ag and low Ba, Mn, Cu and Pb. Trace elements reported at or below the detection limit include Co, As, Se, Sn, Sb, Te, W, Bi, U and Au.

Sulphur isotope analyses on 12 sphalerite samples gave a range of v^{34}S values from + 9.5 to + 12.6 with 9 of the values between + 10.4 and + 10.8. The narrow range of sulphur isotope values may represent metamorphic homogenization (deLorraine and Dill, 1982). The Lime Hill sulphur isotope values are similar but marginally lighter than published values for the Balmat marble-hosted deposits (deLorraine and Dill, 1982; Whelan et al., 1984) and marginally heavier than the range of + 10 to - 10 anticipated for similar sedimentary-exhalative deposits. Whelan et al. (1984) propose that Balmat sulphides precipitated at the time of sedimentation from deep basin brines similar to those proposed for the formation of Mississippi Valley Type deposits and, by analogy, a similar origin may be invoked for the Lime Hill occurrences.

EXPLORATION SIGNIFICANCE

The definition of a gneissic terrane at Lime Hill that is possibly older than the George River Group is significant for mineral exploration. Reconnaissance geology on North Mountain southwest of Campbell Brook indicates that possibly 40% of the area is underlain by gneissic complex and the remainder by plutonic rocks. These rocks warrant investigation for Lime Hill-type mineralization, hopefully of better grade.

Confirmation of the presence of older basement should result in a re-examination of other areas now mapped as George River Group. Recent age determinations (S. M. Barr, personal communication) on the syenite which encloses the marble xenolith host rock to the Meat Cove zinc deposit indicates a Grenville (Helikian) age. This, together with the results reported here, indicates demonstrable zinc potential in carbonate units of pre-George River (i.e. pre-Haydrynian) age. Definition of favourable target areas throughout the carbonate rocks will have to await further definition of the regional extent of pre-George River carbonate.

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MULTIPARAMETER BOREHOLE GEOPHYSICAL MEASUREMENTS AT THE YAVA LEAD DEPOSIT: A PROGRESS REPORT*

*C. J. Mwenifumbo and P. G. Killeen***

INTRODUCTION

A number of holes were drilled by the Nova Scotia Department of Mines and Energy at the west extension zone of the Yava lead deposit in Cape Breton Island during the 1986 field season. Multiparameter downhole geophysical measurements were made in selected holes to investigate the characteristics of the deposit and its host rock. A total of 4 drillholes (403, 405, 411 and 412) ranging in depth from 30 - 50 m were logged with natural gamma ray spectrometry (total count, K, U, Th), induced polarization (IP), resistivity, self potential (SP), temperature, temperature gradient, magnetic susceptibility (MS) and spectral gamma-gamma density methods. This work was carried out under the Canada - Nova Scotia Mineral Development Agreement using the Geological Survey of Canada R and D logging system. The holes were drilled through about 4 m of overburden into coarse grained sandstone containing local black shale sections. The sandstone is underlain by green and maroon shales of the Windsor Group. The basement rocks consists of rhyolite with rhyolite breccia just above the unaltered rhyolite.

GEOPHYSICAL LOGS

Figure 1 shows a suite of geophysical logs and a lithological log of drillhole 405, which includes resistivity, IP, total count (natural gamma ray), density, MS and temperature. The gamma-gamma density data are in counts per second for energy window W7 which is integrated from 0.18 - 0.3 MeV. The count rate is inversely proportional to density. This preliminary examination of the density data is intended to show the variations in a qualitative sense. The ratio of window W7 to window W1 (integrated from 0.1 - 0.12 MeV) is a measure of heavy element concentration (i.e. galena or pyrite) intersected by the drillhole.

The resistivities correlate well with the three major stratigraphic units intersected (sandstone, Windsor Group shales and rhyolite basement). Fairly high resistivites are observed with the sandstone. Lead mineralization occurs as disseminated galena infilling pore spaces in the sandstone. Because of this mode of occurrence, the mineralization does not affect the overall resistivity of the sandstone except where there is electrical continuity of galena between pore spaces. The resistivities of the shales are low while those of the rhyolite are high. High IP effects are observed within the mineralized sandstone. The Windsor shales and the rhyolite basement rocks can be differentiated, as the shales have relatively higher polarizabilities than the rhyolite. There is a significant high frequency component in the IP signature of the shales.

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*Funded by Geological Survey of Canada under the Canada - Nova Scotia Mineral Development Agreement

**Geological Survey of Canada, Ottawa, Ontario

The natural gamma ray log also correlates fairly well with the three major stratigraphic units. The sandstone unit is characterized by low radioactivity, the Windsor shales have slightly higher radioactivity than the sandstone and the rhyolite can easily be delineated by significantly higher radioactivity. Within the sandstone unit the increases in radioactivity correlate with the black shales. Most of the radioactivity within the shales is attributable to potassium and uranium. There is a gradual increase in radioactivity with depth towards the rhyolite breccia, due to increasing proportions of rhyolitic material within the Windsor shales as one approaches the basement. This trend is also observed in other drillholes.

The density log (W7) shows high densities within the mineralized sandstone, with low densities just below the overburden. Since most of the sandstone is mineralized, it is difficult to compare the densities of the sandstone to those of the shales. Lead mineralization is clearly shown in the ratio log (W7/W1) of the density measurements. Lead mineralization also occurs within the Windsor shales and in the rhyolite breccia. The locations are clearly indicated by anomalies in the density ratio log. The relatively small variations shown in the MS log (which usually relate to magnetite or ilmenite variations) within the Windsor shales and the sandstone unit will require a detailed study of the core for their interpretation. The temperature log shows two prominent anomalies caused by groundwater flow, one near the base of the Windsor shales and the other near the base of the sandstone unit.

It appears that in surface exploration for lead mineralization, the optimum technique would be IP. Within the borehole, density and IP measurements are a good indicator of lead mineralization. A second phase of drilling and logging is planned for October-November 1986.

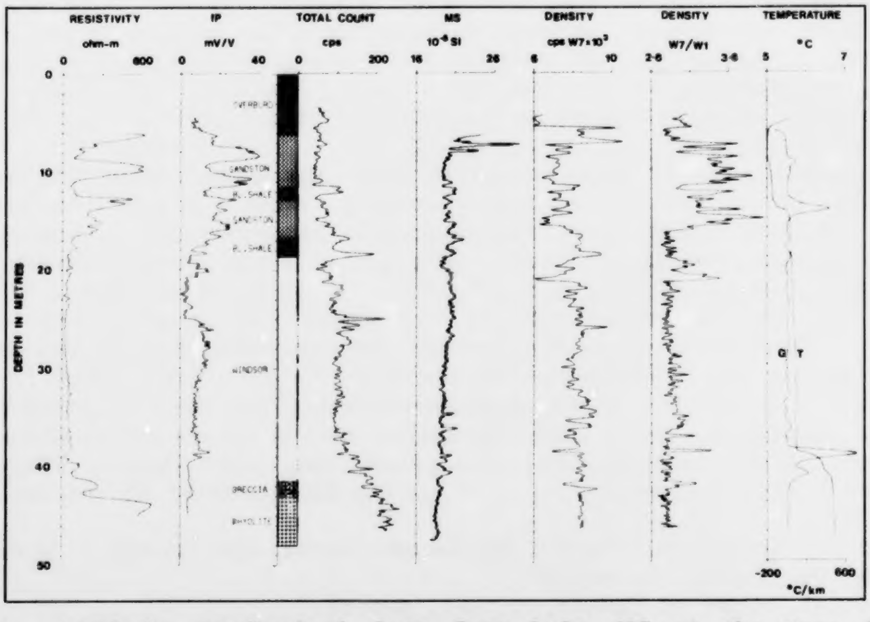

Figure 1. Borehole geophysical logs from hole 405 at the Yava deposit. Recorded with the Geological Survey of Canada R and D logging system, the logs shown here include Resistivity, Induced Polarization (IP), Total Count (natural gamma), Magnetic Susceptibility (MS), Density (W7), Density Ratio (W7/W1 i.e. heavy element content), Temperature (T) and Temperature Gradient (G).

COMPUTERIZATION OF COAL EXPLORATION DATA FOR NOVA SCOTIA*

*J. D. Hughes**, P. D. Watson*** and D. J. MacNeil****

Construction of computer files of coal geological and coal quality information for Nova Scotia coalfields continued in 1986, under the Canada - Nova Scotia Mineral Development Agreement. For an outline of the rationale, procedures and objectives of the project, the reader is referred to Hughes, MacNeil and Watson (1986).

The first phase of the project (fiscal year 1985-86) entailed preparation of files for the Sydney coalfield and other smaller coalfields of Cape Breton Island. This involved compilation, interpretation and coding, as well as verification of location, lithological and coal quality data from some 785 boreholes totalling 72 076 m. This total is some 10 000 m short of original projections due to over-estimation of availability of data from miscellaneous boreholes drilled in the early part of the century. Analytical data for 929 samples of coal seam intersections from the boreholes have been entered. As well, data for some 2000 channel samples from underground mines have been entered into the database. As the logistics of handling a large number of channel samples, each with an average of 6 individual ply analyses, is more time consuming than anticipated, entry of the remainder will be continued this year.

Other information required for coal deposit modelling in the Syndey coalfield such as detailed topographic, bathymetric and seafloor sediment maps are being digitized, and converted to a common co-ordinate base (6°UTM).

During 1986-87, all coal exploration data from the Cumberland Basin and the Debert coalfield will be completed. The available information includes 395 boreholes totalling about 48 500 m, approximately 70 outcrop descriptions and 1250 coal sample analyses. Digitizing of the relevant topographic maps will also be done.

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**Geological Survey of Canada, Institute of Sedimentary and Petroleum Geology, Calgary, Alberta

***c/o Energy Resources Division, Nova Scotia Department of Mines and Energy, Halfiax, Nova Scotia

MEGUMA QUARTZ VEINS, TANGIER AREA*

*C. Hy*** *and P. F. Williams***

The purpose of this study is to determine the geological history of the quartz veins which are abundant in the Meguma Group. On-going work on gold-bearing veins has confirmed that the veins are true dilatant structures. Henderson (1983) interpreted the veins to be post-cleavage but pre-folding. Mawer (1985) suggested that they are possibly synchronous with the folding and also related to Devonian plutons, but this is contradictory because the folding is likely pre-Devonian. To further investigate these problems, the shoreline from Ship Harbour to Sheet Harbour was mapped, as were the major islands of this area (Nicholl Island, Borgles Island, Tangier Island, Gerard Island, Phoenix Island and Pyches Island) and part of the small past-producing Mooseland Mine.

In the southeastern part of the islands, different types of veins have been recognized: bedding parallel veins, en-echelon veins related to the southern anticline as well as a-c joints parallel to veins, and breccia type veins in the numerous northwest-southeast fault zones. Characteristics of the host rocks are: (1) well preserved sedimentary structures especially in sandstones (channels, graded bedding, cross-laminations, etc.); (2) a poorly developed pressure solution cleavage in sandstones which is better developed in the shales; and (3) a mineralogy comprising detrital quartz, plagioclase, sphene, pyrite and a foliation composed of quartz, white mica and chlorite. The metamorphic grade is very low greenschist. Both bedding-parallel and en-echelon veins are almost pure quartz with rare plagioclase and opaques.

Bedding-parallel veins and en-echelon veins are geographically related even though they are not directly connected. Bedding-parallel veins are barely boundinaged yet exhibit a rather strong surface striation. En-echelon veins are stretched, boundinaged and folded. Shales surrounding the en-echelon veins are folded, kinked, fractured and exhibit an axial plane fracture cleavage related to this deformation. The most satisfactory explanation of this deformation is that it occurred during large-scale folding, in agreement with Henderson's (1983) idea of rotation of the en-echlon veins during this event. This hypothesis needs further investigation.

Inland from the coast metamorphic grade increases, the folds tighten and east-northeast/west-southwest post-plutonic shear zones appear. Mapping of the Mooseland Mine was conducted to further establish the timing of veining and the possible relations between veining and post-plutonic shear zones.

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**University of New Brunswick, Fredericton, New Brunswick

The Mooseland Mine is situated on the Mooseland-Gegogan Anticline hinge. It is a normal plunging tight fold with a well developed axial planar foliation. Detailed observations indicate a long history of veining:

1. A few veins clearly formed before the axial planar foliation. They are extensively buckled.

2. Some veins are bedding-parallel. They turn around the hinge, cut through the axial planar foliation and are slightly pinched and swelled. Quartz in these veins is deformed. It is still unclear if this is due to folding (the veins would form before the anticline formation) or further stretching (the vein could have formed during or after the folding).

3. These earlier veins are cut by 3 sets of mutually perpendicular veins, one of which is bedding-parallel. They cut through the cleavage, the anticline hinge and the earlier veins. Apparently they are only slightly deformed.

4. Finally, the largest quartz veins ($\geq$60 cm thick) contain large undeformed quartz crystals. These veins were emplaced along existing discontinuities and commonly contain older vein material.

The rocks in the Mooseland Mine area are crossed by a large shear zone which boundinaged, stretched and folded the first three types of veins but not the fourth. The strike of the shear zone is parallel to the strike of the bedding. A new foliation, defined by a middle greenschist facies assemblage, dips steeply to the south. A strong stretching lineation is associated with the shear zone and plunges southeast. This shear zone shows clear resemblance to another shear zone which has been identified in East Ship Harbour. The strike of the shear zones, the metamorphic grade and the stage of occurrence (late plutonic) indicate that they may represent the same event. Furthermore, this occurrence of a second foliation and a strong stretching lineation in middle greenschist facies rocks, superimposed on earlier foliation of various grades in the slates of this area, is not an isolated one. These features are also present at other visited mines (Caribou, Fifteen Mile Stream, Harrigan Cove, Moose River and Tangier). The largest quartz veins (type 4) at Mooseland are unaffected by the shearing, thus indicating developement later than the other veins.

By integrating the elements described above, a geological history of the veins in the Tangier area is proposed. The first quartz veins were injected into lithified rocks not as yet subjected to folding. This is seen on the islands where veins were deformed during folding. During and after folding, vein injection continued parallel to bedding as well as perpendicular to the fold axis (a-c direction), as evidenced in the area of the Mooseland Anticline. These veins, as well as the first, were folded, stretched and boundinaged by late plutonic shear zones which do not affect the largest quartz veins (as also seen at Mooseland). The discontinuity planes created by these shear zones may have provided migration paths for fluids released by the plutons and(or) by dehydration reactions in the contact aureole. These fluids may have been subsequently trapped in the anticline hinges. Study is continuing to ascertain at which stage of this geological history gold was introduced.

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DEPOSITS RELATED TO THE COBEQUID-CHEDABUCTO FAULT SYSTEM*

*W. B. Ervine***

SUMMARY OF POSTER DISPLAY

The Cobequid-Chedabucto fault system is a major structural feature marking the boundary between the distinct geological regimes of northern and southern Nova Scotia. The system consists of a series of long, near-parallel faults which together extend from Cape Chignecto at the head of the Bay of Fundy eastward to Canso on Chedabucto Bay, a distance of more than 300 km. Movement on the fault system is believed to have begun during the Devonian and continued with periodic dip- and strike-slip movement at least into the Jurassic. Other faults, probably related to this system, cut adjacent Carboniferous Basins, the Cobequid and Antigonish Highlands and the Meguma Terrane.

Fractures and breccia zones related to this prolonged period of faulting are mineralized within a broad zone paralleling the fault system. Over 200 mineral occurrences ranging in size from small pits unexplored for over 100 years to large underground operations have been recorded. Field examination of these occurrences indicates that primary mineralization consists mostly of iron oxides and carbonates; manganese oxides; copper, lead and zinc sulphides; native copper, silver and gold; and barium sulphate. Many of these occurrences have been selectively sampled for analytical work. A few representative suites are on display.

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